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The Journal of HEREDITY

A monthly publication devoted to Plant Breeding Animal Breeding and Eugenics

A DRAGON MILLIPED
O. F. Cook

BOTTLE GRAFTING AGAIN
A. F. Blakeslee

ENDOSPERM DEFECTS IN MAIZE
R. J. Garber and B. L. Wade

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THE "PINTO" BURRO
T. C. Richardson

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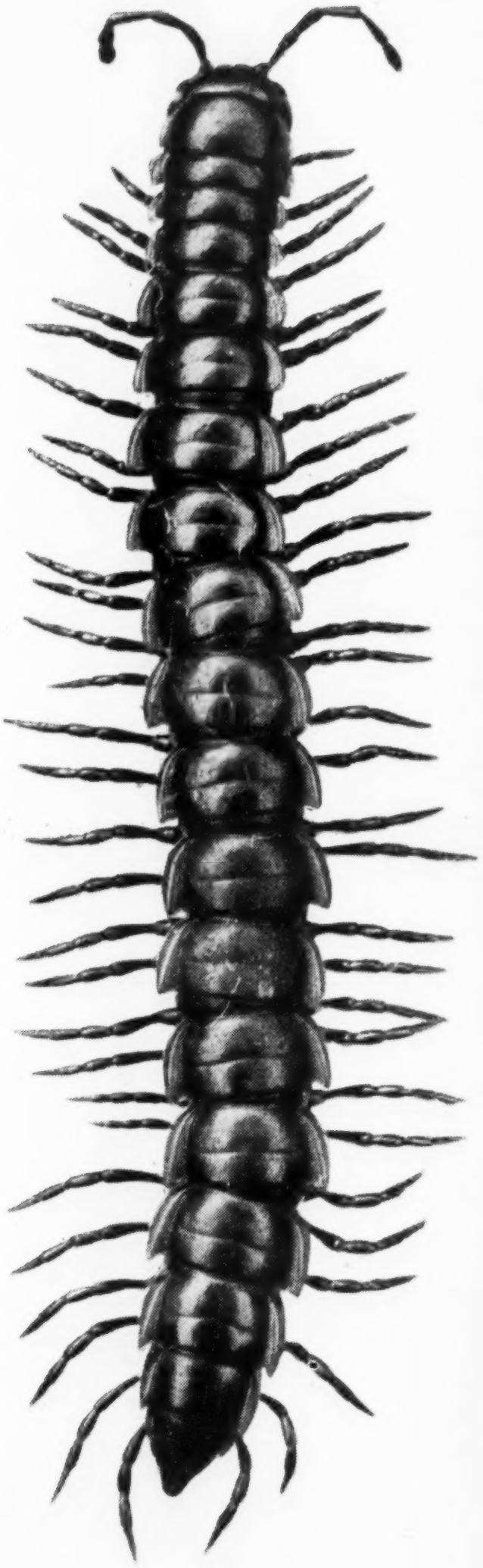
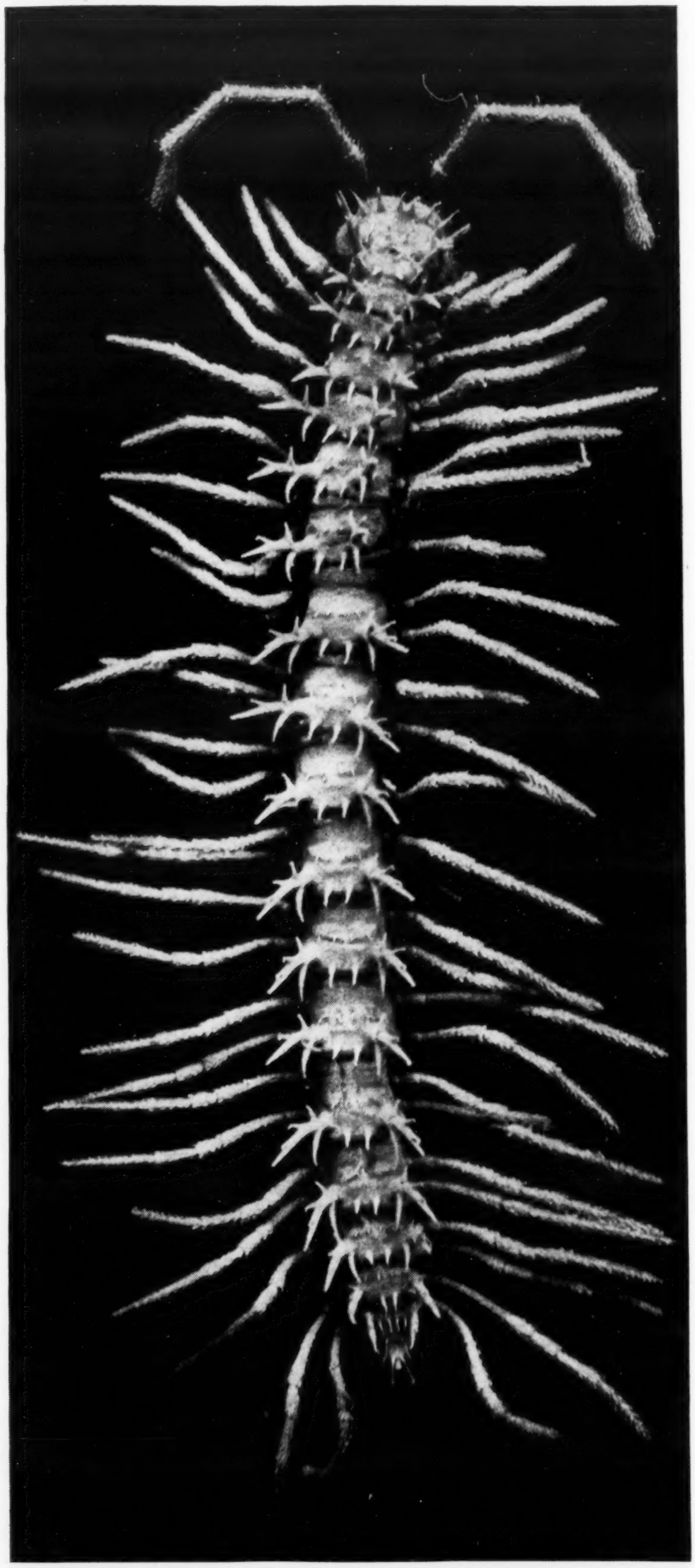




TWO CHINESE MILLIPEDS

The "dragon milliped" *(Hylomus draco)* of the Lu Mountains of Central China, in comparison with *Orthomorpha pekuensis,* a milliped of ordinary form, from the Temple of Heaven, a few miles south of Peking. The dragon milliped shows extreme development of the spines on the segments, not paralleled in any living type, but suggesting some of the extinct forms of the remote Carboniferous Age. Hylomus is magnified nine times, Orthomorpha five times.

A DRAGON MILLIPED IN CHINA

An Extreme Type, Showing That Evolution is Not Limited To Useful Characters

O. F. Cook and H. F. Loomis

U. S. Department of Agriculture

BIZZARRE developments are expected from China in customs and arts, but nature also shows fantastic moods in the "Celestial Empire." The unicorns, dragons and lions of the Chinese mythology and folk-lore are very weird creatures, but imagination again is outdone by reality. In the mountains called Lushan, south of Kiukiang, Central China, a milliped has been found which needs only to be exaggerated in size to appear as a terrible dragon. The prevailing style in dragons, of course, is reptilian, but if such creatures were actually discovered they could hardly be more remarkable, in the sense of being more divergent from other members of their class, than is this new milliped.

Other countries have their peculiar millipeds, but China may claim the palm for a creature with no parallel among the living members of this class of animals. Each segment of the body carries a pair of branched dorsal processes of relatively enormous size, and shaped like trunks of trees. In allusion to the form of the processes, the name Hylomus, meaning "Forest-Back," has been applied to the genus. It has not been supposed that any existing milliped could compare with the Carboniferous fossils as examples of extreme development of spines on the segments, but Hylomus is a living marvel that may compete with the antediluvian wonders.

Reference to the photographs will show the wide departure of Hylomus from the usual form of the segments in this order of millipeds, as represented by another Chinese species, *Orthomorpha pekuensis*. Many millipeds have lateral flanges or "carinae," which in Hylomus are replaced by the large branched spines. Some millipeds have the lateral carinae more expanded than in Orthomorpha, with margins that may be notched, saw-toothed, or scalloped, or the corners may be long and sharp, but these specializations are very slight in comparison with the tree-like out-growths on the segments of the new type. Not only a new genus but a new family, Hylomidae, has to be established in order to place this strange animal in the system of classifiction.*

Analogy with Cave-Dwelling Forms

In addition to the great dorsal processes, Hylomus is remarkable in the excessive length of the antennae and legs, which project on each side for more than twice the diameter of the body. The extreme attenuation of the appendages, with the exaggeration of the spines of the segments, suggests an analogy with the lengthened extremities of animals that live in caves. It is well known that cave-dwelling insects and crustaceans often have much longer antennae and legs than related outdoor forms, and similar modifications appear also among millipeds that inhabit caves. The Chinese milliped was not found in caves, but in the humus layer of the soil under coppice growth of chestnut and other deciduous trees. A subterranean fauna might exist, since the Lushan valleys have rocky out-crops where swift mountain

*A new Family of Spined Millipeds from Central China. *Jour. Washington Academy of Sciences*, 14:103. March 4, 1924.

streams have cut narrow gorges and pot-holes.

The principal locality for Hylomus is on the left bank of the stream a few rods above the "Emerald Pool," below "Three Trees" which mark the site of the "Yellow Dragon Temple." Many localities in China claim the distinction of being inhabited by dragons, but the dragons of the Emerald Pool are the first to be captured and described. Of course some will be disappointed with dragons that are only an inch long, but in a scientific age we can marvel at small creatures. Primitive people could only exaggerate, but science has learned how to magnify, so the question of absolute size is of little importance.

Evolution of Specialized Characters

Interest attaches to such cases of extreme development as Hylomus, in their bearing upon the question of evolutionary causes. So great a development of spines on the segments appears excessive and abnormal. In such cases evolution seems to have been carried beyond the range of advantage or utility to the species. Other examples of apparently over-developed organs have been described, both in living and in fossil forms, like the extinct Irish elk with their massive horns, and the saber-toothed tigers. Parallel developments or repeated evolutions and extinctions of specialized forms in successive geologic epochs are recognized in some groups of animals.

That it is possible for useless or harmful characters to develop is not in accord with the doctrine usually called Darwinism, which treats of natural selection as the cause of evolution.. Wallace described selection as "the motive power of change," and this idea has been accepted by many writers. The argument for selection has appeared logical, but there has been no practical explanation to show how the selective elimination of some members of a species could be responsible for changes of characters among the survivors.

Selection is the veto power of the environment, to forbid the development of characters that conflict with the actual conditions of existence, but other characters may change without interference by selection. Variations that are not rejected by the environment may become established and spread through the species. For selection to take place, differences of adaptation must exist. Also, the better adapted and more abundant a species becomes, the more acute and competitive are the struggles of individuals for existence. Thus it appears that the influence exerted by selection depends upon evolution, instead of evolution being dependent upon selection. The environment has the power to restrict evolution, but should not for that reason be supposed to cause evolution.

Millipeds Show Nature of Evolution

The nature of evolution is illustrated in a special way by the millipeds because the habits and environmental relations of these animals are but little diversified. The group as a whole has a remarkable ecological unity. Millipeds of all countries, including hundreds of genera and thousands of species, live in the leaf-mould or in the humus layer of the soil and feed as scavengers upon the decaying vegetable matter. The humus layer of tropical forests is as uniform an environment as could be found, but milliped faunas generally are larger in the tropics than in temperate regions.

Practical tests or demonstrations of evolution are difficult to make, on account of the requirement of large numbers of individuals and long periods of time, but by considering the evolutionary status of whole groups of species we get the effect of a large experiment conducted on hundreds of species, as it were, a general test of the supposed relation of selection to evolution. If peculiarities of environment cause differences in characters to be developed, little or no evolution should be expected in a group whose members live

under the same conditions. The evolution of so many species, genera and families of millipeds appears quite superfluous from the standpoint of adaptation. The evolutionary diversification of the group has gone forward with no corresponding ecological diversification to require changes of habits or adaptations to external conditions. There is little to support the idea that the differences between the species and genera are brought about by selection or by differences of environment. In addition to the uniformity of habits, many of the differences are of a nature to have little or no relation to the environment.*

A requirement of special conditions may be recognized to make possible the evolution of an extreme type like Hylomus, without assuming that the evolution has been caused by the special conditions. Animals with such long appendages require more space. No doubt the large spines would interfere seriously with the movements of an animal living under ordinary humus-layer conditions. The humus layer under the coppice growth where these millipeds live is of unusually firm texture interlaced with many roots, with small chambers and passages excavated by rodents or by burrowing insect larvae. These cavities and burrows may be considered as affording cave conditions on a very small scale, but apparently sufficient for the needs of the species. Cave-dwelling species have ample space and the usual limitations of size or length or appendages are removed, thus permitting the development of appendages that under ordinary conditions would be seriously disproportionate and disadvantageous. On the other hand, the cave animals or other specialized forms tend to be restricted to the special conditions where the extreme characters have been developed.

*See Evolutionary Inferences from the Diplopoda. *Proc. Ent. Soc. Wash.*, 5:14-20. 1901. Also New Tropical Millipeds of the Order Merocheta, With An Example of Kinetic Evolution. *Proc. U. S. Nat. Mus.*, 40:451-473. 1911.

A Handbook for Genealogists

FAMILIENFORSCHUNG UND VERERBUNGSLEHRE, by ROBERT SOMMER, Professor at the University of Giessen. 2d ed., pp. 358. Leipzig, Verlag von Johann Ambrosius Barth. 1922.

Dr. Sommer, a psychiatrist, has outlined the field of genealogy and focused on it a great deal of genetics, anthropology and psychology. Unfortunately he deals largely in generalities, and the book would have been much more useful as well as interesting if these generalities had been illustrated by the wealth of detail and example that might easily be assembled. The lack is partly made up of a special detailed study of the lives of some great Germans and others not so great but worthy of study—the last Kaiser, for example. The final chapter devotes some sixty pages to a very detailed study of the author's own ancestry, which he offers as an example of method. Dr. Sommer devotes some attention to the question of "natural nobility" as compared with the official nobility of European countries—his views are sound. There is no book in the English language that covers the proper field of genealogy fully and future writers, while they will improve on Dr. Sommers' volume in detail, will have very largely to go over the same ground. P. P.

BOTTLE GRAFTING AGAIN

Invention the Daughter of Necessity

A. F. Blakeslee

Station for Experimental Evolution, Cold Spring Harbor, Long Island

A SHORT article on Bottle Grafting by Mr. Farnham and the writer in a recent number of the Journal of Heredity has elicited a number of letters in regard to previous mention of the method in the literature. It seems that descriptions of it are to be found in the European writers. In this country it was described and figured by A. S. Fuller in his *Propagation of Plants* published in New York in 1887. A brief account of it was given in the original edition of Bailey's Nursery Book in 1891 and a statement about it is in the *Nursery Manual* which is the current issue of that book.

In the 1913 *Proceedings* of the Northern Nutgrowers Association, Dr. R. T. Morris reports it as a new method he had devised for grafting nut trees and adds the suggestion that a sprig of Utricularia or other pond weed be placed in the water in the bottle to make a balanced aquarium and prevent the development in it of harmful organisms. Such a precaution we imagine might well be an advantage with woody material when it was necessary to keep the nurse bottle functioning for a considerable time before weaning the scions, but we have not tried this modification with our material.

It seems that the method has been independently rediscovered a number of times like many other methods adapted to special purposes but not to universal application. Invention, like other work, is forced on mankind by necessity. The familiar adage concerning the relationship between necessity and invention, however, cannot stand the test of biological scrutiny since, among the countless daughters of necessity, sisters with widely separated birthdays are frequently discovered to be identical twins.

We are not greatly ashamed of having neglected to look more thoroughly into the earlier literature on grafting before publishing our brief article since we had attempted to avoid infringing upon the possible patent rights of other workers by saying, "Doubtless this method has been used by others, since it is a natural means of obviating the difficulties encountered in attempting to graft slow-growing scions." The present penitent note we are writing at the request of the editor. We publicly confess that we have no rights of "priority" in the discovery of bottle grafting although we are still finding it a useful method with Jimson Weeds and believe it may be of service to other geneticists. Until our record is taken from us, however, we can claim posteriority in rediscovering a discovery which has been discovered more than once before.

THE OFFSPRING OF THE MORMON PEOPLE

J. E. Hickman

Logan City, Utah

Note:—This investigation has an interest quite apart from any idea of defending the system of "Plural Marriages." The wish to avoid or remove any implication of the inferiority of such families is natural, and we are glad to give Prof. Hickman the opportunity to state his results. The religious question involved is, however, quite beyond the province of this Journal, and we have shortened the paper to the extent of omitting discussion of that phase of the matter. We have also presented only part of Prof. Hickman's statistical data. The details only bear out what appears in the tables, and we would be glad to furnish the complete tables to any one interested in a more refined analysis.

The fact that plural families were restricted by church authority to a select class of the population would explain the general average superiority of the polygenous families, and those classified by Prof. Hickman as of "indirectly polygenous" origin. The monogamous population would, of course, be weighted with all the cases of recognized inferiority. Brigham Young is said to have told an unpromising applicant for the plural family status: "No, we don't want to raise any more of your kind."

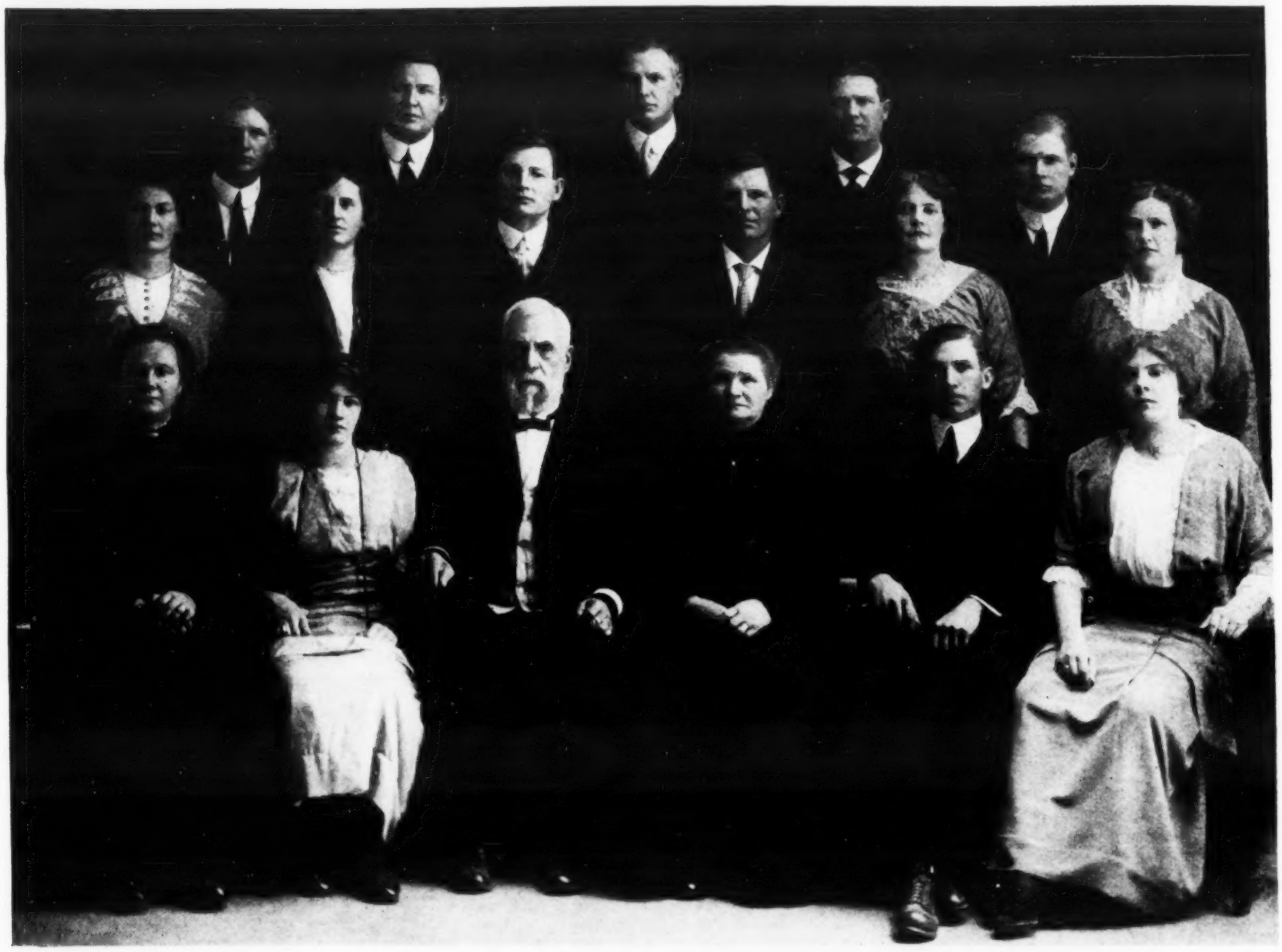
That the differences are so pronounced after so short a period of selection is of great interest and leads to the hope that other methods of encouraging the mating of the hereditarily well endowed would produce striking results in few generations. Prof. Hickman's data are unusually pertinent, because the effects that may be expected from selection can seldom be investigated so directly in the human species.—*Editor.*

ANY startling innovation in the social fabric of a nation is fraught with disturbance which often results in bitter strife. When the principle of plural marriage was announced as a tenet and practice of of the Mormon religion it agitated the public mind from center to circumference. Severe arraignments were made against that people. They were attacked from pulpit to senate hall until the prejudice against them amounted almost to a national hatred. The direst results were prophesied against such a system of marriage. Claims were made that it produced dwarfed, ill shapen and demented offspring, fostered ignorance, crime and squalor. So thoroughly have these ideas redintegrated into the mind of the public that they pass in certain circles as unquestioned facts. In view of these claims the writer has made a critical study of the mental and physical traits of the offspring of the Mormon people.

It is not necessary here to review the various arguments for and against this principle of marriage; but in passing it may be well to note that it was legislated against in 1882, the act being known as the Edmunds Law. Prosecution under this law began about 1882 and did not cease until 1893. The people fought their case through the Supreme Court of the United States. When this body declared that the law against polygeny was constitutional the people, in open assembly in 1890, decreed to abandon its practice. This act is in accord with one of their principles which says that they are willing to be subject to kings, presidents, rulers, and magistrates and in obeying, honoring, and sustaining the law.

But before the hour of relinquishment came they suffered long years of bitter prosecution. The people felt that it degenerated into persecution, so relentlessly were they hunted down.

During that period over two thousand five hunderd men were imprisoned. At one time the penitentiaries in Arizona, Utah, and Idaho were filled with "co-habs" as they were called. In that emergency the govern-



A POLYGENOUS FAMILY

FIGURE 1. Eight members of this family have had college training, and six hold doctors' degrees. That they are not afflicted with many physical ailments is evident from the picture. The polygenous families of the Mormon people are the product of eugenic selection, at least to the extent that "the fool and the dwarf were forbidden to perpetuate his species on the polygenic plan, as he should be excluded from any system of marriage."

ment chartered the state prison at Detroit, Michigan, and sent many of the prisoners there. Hundreds of the polygamists were absent from their homes for years either in penitentiaries or in hiding until their children did not know them. Women also were in hiding; babies were born in caves, mountain defiles, and in secluded spots of the desert. Fortunes were wasted and homes made desolate. This, in part, was the sacrifice made by those who would not renounce this principle or set their families adrift. Of the thousands imprisoned, liberty and amnesty were offered to each if he would abandon his wives and children; but, be it to their honor, not one accepted the olive branch at such a sacrifice.

Methods of Procedure

The writer began, a number of years ago, carefully and critically to gather data on this subject until he had weighed and compared nearly twenty-four thousand persons, 2,682 of whom were of polygenous origin; and 20,501 of whom were of monogamic origin Of the twenty-four thousand, 1,275 were students. Of these 708 were of monogamic origin; 277 were of polygenic, or plural origin; 220 were of indirect plural origin. By indirect origin is meant those whose parents, one or both, were of polygenic origin but who were not living in that system themselves.

The small blanks (Table VII) were filled out by the students themselves, except in answering the last question.

A MONOGAMIC FAMILY

FIGURE 2. A comparison between physical measurements of Mormon students and the students in the schools of the larger cities is given in Table V, and from this it appears that the Mormon stock is superior physically. The wanderings of the Mormon people and their subsequent struggle with an unfriendly environment in Utah would be expected to eliminate the weakling and the sluggard, a result which is confirmed in the present investigation.

The measurements of height were mostly made by myself or instructors in charge of classes. The weight was given by the students. Those who did not know their weights were permitted to make a special weighing for the occasion. The ages were given in years and months; height was recorded in feet and inches to a sixth of an inch. The intellectual standards were given in per cents, which were obtained from the instructors. After the standings of the students were marked on the cards, the percentages were averaged; this gave the mental measure of the students[1] from several standards.

By averaging the ages, height, weight, and estimated intellects of each class, the writer obtained the data shown in Table I.

It is shown in this table that the boys of polygamous origin are younger than the monogamic boys and that the "IP" boys are younger than either of the others.

The boys of Class P are three inches taller, eight pounds heavier, and nearly seven per cent above those of Class M in school marks. A slight superiority of class IP over Class M is shown. Comparing the girls in the same ways as the boys it is found that the girls

[1] The term Class M or simply M shall be used to mean those of monogamous parents, the term Class P or simply P to mean those of polygenous parents, and the term Class IP or simply IP to mean those of polygenic grand parents.

MONOGAMIC AND PROLIFIC

FIGURE 3. The average number of children in the Mormon families was found to be 7.2 in the monogamic group and 5.75 in the polygenic group, counting each wife and her children as a family. At the time of this study the average number of children per family in the United States as a whole was 2.76.

of Class P are superior in weight and intellect but those of Class M are slightly taller..

There is a possibility of an error in this method of computing, due to the fact that the boys and girls in one class may be younger on the average than those in the other. For example, if there are thirty girls eighteen years old in Class M, and these figures were reversed with Class P then there would be a seemingly greater difference in height and weight than really exists. For that reason the writer has grouped each class by years, before averaging their physical and mental standards. By so doing different results are obtained, yet by both methods Class P are shown to be superior to Class M.

This last method is strictly accurate and shows the real differences as they exist. The data for these conclusions are given in Tables II and III. The reader will observe that the males[2] range from fifteen to twenty-six years.

The boys of Class P are taller than those of Class M. On the average, the modes of the P's are 1.2-5 inches superior to the mode of the M's; the medians of the P's are 1.04 inches taller than the medians of the M's; the average of the P's are .66 inches taller. Taking into consideration the three measurements it will be seen that the boys of plural origin, on an average, are about an inch taller than the

[2] A few were over this age but they were included with those twenty-six years old.

GRANDCHILDREN OF A POLYGENOUS MATING

FIGURE 4. Their parents, however, practiced monogamy, so that these children are of indirectly polygenous origin. This group stands between the polygamous and monogamous groups in physical measurements and intellectual standing.

sons of the same age of monogamons parentage.

Comparing their weights, the modes give a difference of 5.63 pounds in favor of Class P; the medians a difference of 4.8 pounds; the averages a difference of 9.51 pounds in favor of Class P. In intellect, the mode shows them to be 6.99 per cent superior; in the median 4.49 per cent; and the average 3.17 per cent above the M's. Class P seems to be nearly five per cent above Class M in their work.

By referring again to the same table it will be seen that the boys of Class IP are nearly equal in height, weight, and intellect to those of Class P.

The same persistency in superiority is shown in comparing the girls of Class P with those of Class M (see Table III). By the mode, girls of Class M are .33 of an inch above those of Class P; but by the median the girls of Class P are .71 inches taller, and by the average they are one inch taller than the M's. The average and median are more reliable measures than the mode, and therefore it may be inferred that the girls of plural origin is taller by about three-fourths of an inch. According to the mode, the girls of Class P are 4.95 pounds; according to median, 5.58 pounds; and according to the average, 3.59 pounds heavier than the girls of Class M. A truer view may be had by examining the measurement for each age (See Tables II and III). In intellect the girls of Class P are 3.39 per cent higher by the median, and 2.84 per cent higher by the average.

The IP girls are nearly equal in height, weight, and intellect to those of Class P.

The statistics reveal the fact that the male and the female of polygenic parentage are superior mentally and physically to those of monogamic parentage. Yet the boys and girls of Class M of the Mormon people, as measured by the writer, are taller and heavier than those of the northern, middle, and eastern states, according to the figures of Dr. F. Boas, who measured students in Boston, St. Louis, Milwaukee, Worchester, Oakland, and Toronto. His results are compared with the writer's in Table V.

These figures reveal that the Mormon children of monogamic parents are decidely superior in height and weight to those measured by Dr. Boas. A similar measurement was made on two different sets of students, with like results. All boys of Class M from fifteen to twenty-six years of age, are on an average, 5 feet 8 inches tall. But the average height of those over twenty years of age, is 5 feet 8.54 inches. The average height of the boys of Class P (from 15 to 26) is 5 feet 9 inches; but the average height of those over twenty years of age, is 5 feet 11 inches; then at least half of the polygenous adult men stand at least 6 feet in height.

Comparing the height of the school girls who are over ninteen years of age, it is found that the girls in Class M average 5 feet 4.5 inches while the girls in Class P average 5 feet 5.9 inches. It may be interesting to know that the average weight of the girls in Class M, over eighteen years of age, is 129.93 pounds while the girls in Class P of the same age weighs 134.35 pounds. The average weight of the boys in Class M over nineteen years of age is 156.22 pounds, but the average weight of the boys in Class P of the same age is 160.45 pounds. By reference to the tables, it will be seen that the indirect plural offspring nearly parallel in all measurements, those of direct plural origin. This close paralleling would be expected, for it is a well known law of heredity that any new physical characteristic in man, animal, or plant tends to be perpetuated for two or three generations[3]. It seems from the figures that there is a greater difference in weight between Class P and Class M than there is in height, showing that those of plural origin are a little better proportioned and hence one may infer they are healthier. This is borne out by the fact that there are fewer deaths among those of plural origin. These differences of superiority of the polygenic issue—direct and indirect—over the monagamic are too constant and are taken from too large a class to be due to chance. The work has been too carefully computed to leave room for numerical errors, therefore the conclusion is that the children from such a source are endowed from birth with a physical and mental advantage that manifests itself throughout the history of the individual. This fact will be more conclusively shown farther on.

A Study of the People at Large

This now completes the review of the 1300 students. We will now turn to the consideration of the data gathered, mostly by the writer, from forty-one towns and cities, only one of which had more than 3,000 inhabitants. The results of this investigation are tabulated in Table VI.

All except three of the towns and cities from which the writer got his information were remote from the larger centers of education; and twenty-six were distant from railroads. They were purposely chosen for the following reasons: First the settlements were small and the information could be the more readily and accurately obtained. Second, the writer wished to know the standard of the people who were not so favorably located and who were still grappling with the desert. Third, that he might not be accused of selecting those who had had greater advantages. The responses to all the questions but Number 7 (Table VII),

[3] *Environment and Heredity--Modern Studies in Experimental Evolution*, by Dr. McDougal, pp. 122-3.

THE TOWN OF HURRACANE, UTAH

FIGURE 5. The average rainfall in this region is twelve inches. Before the arrival of the Mormons it was a desert. Irrigation has transformed the valley into a thriving farming community. This valley is typical of the country which the Mormons occupied after their long journey from the East.

give information concerning the entire Mormon population in these settlements. In the case of Number 7, it was almost an impossible task to get figures regarding the monogamic families from the entire population. The author therefore got data on births and deaths, as a rule, from three to four times as many monogamic families as polygenic. This method is fairly reliable, for according to the law of random selection, with such a large number the true estimate will be given within a small fraction of one per cent.

The data include 22,332 persons. Of this number 19,916 were offspring of monogamic parents and 2,416 were of polygenic origin. They were divided into 3,680 and 481 families. (Each wife and her children were counted a family). This gives 5.4 living children to each monogamic family. As one-fourth of the children had died, the average children to a family would be 7.2. Each wife, in polygenic families, averages 4.6 living children; adding to this number one-fifth more who are dead, the average is 5.75 children to each mother. This gives a majority of 1.45 children to each monogamic family. It may be of interest to know that the above children do not measure the complete number to the family, for some of these families were still bearing children. The above averages seem high when we learn that in the United States there are, on an average, only 2.76 children to the family.

Inasmuch as plural marriages ceased in 1890, only those plural families[4] al-

[4]Of the 2,500 plural families in existence at the time of the cessation of this form of marriage, less than 500 now exist (1907). This is counting the man and his wives as a family.

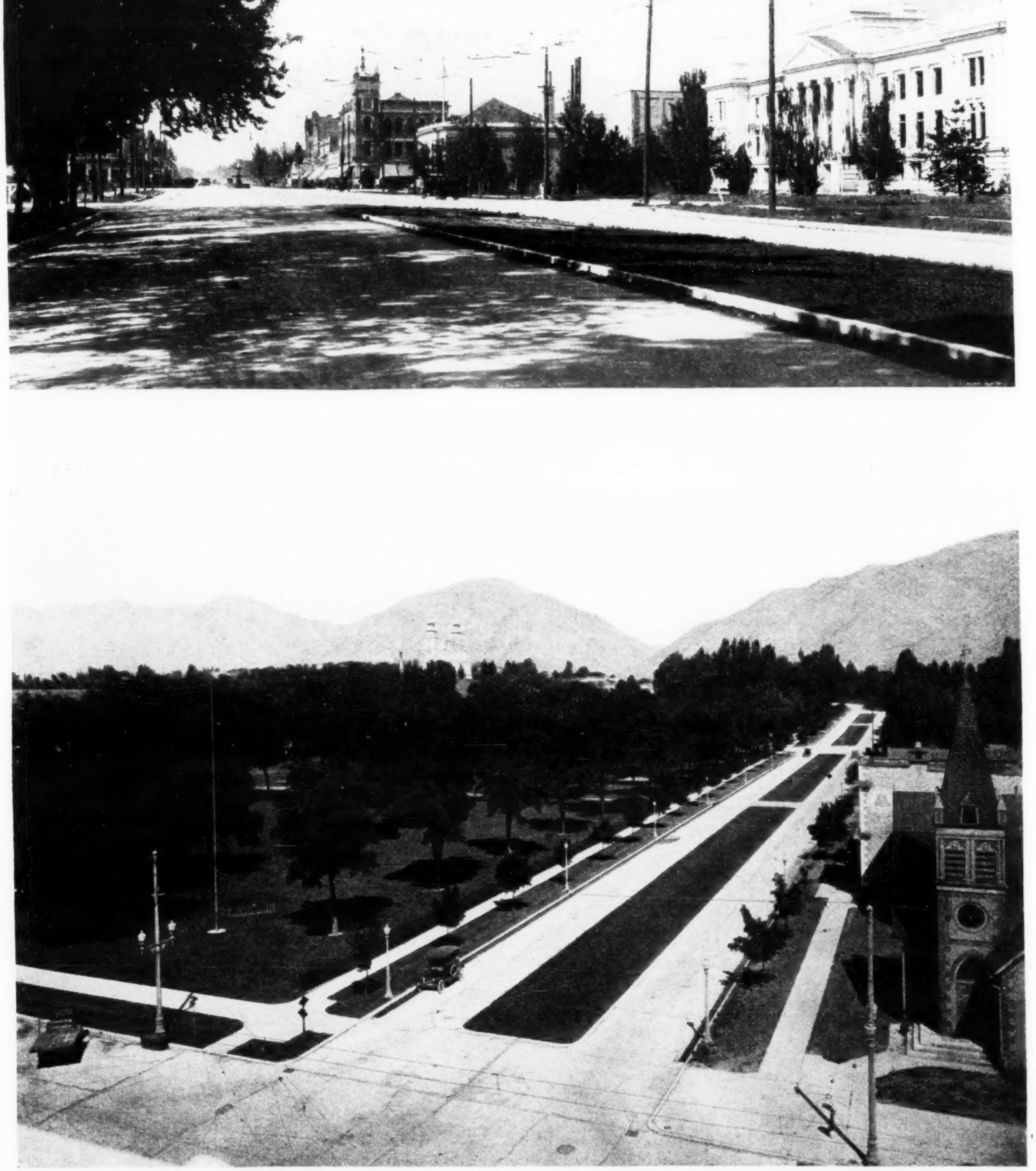
ready in existence continued to bear children. This makes a majority of the plural offspring over twenty-five years of age[5]. Therefore the plural offspring studied, ranged from babies in arms to men and women sixty years old. In getting the birth and death-rate in each settlement those monogamic families were chosen that were about the same age as the polygenic families. But as this was not always possible, in some instances a few monogamic families chosen were younger. If all the monogamic families had been as old as the plural families, there would be shown a greater difference in the death-rate. As it is, one out of four of the monogamic offspring has died, but only one out of five of the polygenics. When we consider that these offspring average from twenty to twenty-five years of age it shows a remarkably small mortality. In the United States as a whole, families of this age show a death-rate of thirty-eight out of a hundred. This small mortality among the Mormons is due largely to their abstinence from narco-stimulants. Less than fifty per cent of the people use tea or coffee; less than seven per cent use liquor or tobacco. In homes where tea, coffee, liquor, or tobacco is used the writer found the death-rate much larger than in abstaining families. In a majority of the families where no stimulants are used the death-rate is almost nil with growing children.

The object in examining the mortality was to learn, if possible, which class—monogamic or polygenic—produced the stronger race. In examining the physical deformities and the mental degeneracy, due to birth or sickness, it was found that one out of every 120 (00.83%) of monogamic children had some defect either physical or mental, while those of the other origin had only one defective in 172.57 (00.58%). Any abnormal physical condition, even cross-eyes (strabismus), stammering, tongue-tiedness, and so forth, was considered a physical defect and so counted. Just as close a scrutiny was observed for mental defects. In the United States there is one in every 212 who is either insane, feeble-minded, deaf, or blind. Add to these all other defects and it would be more than treble the number, making at least one defective in sixty.

Of the 19,916 offspring of the monogamic, one out of twenty-five attended some high school, academy, or college. But of the 2,416 offspring of the polygenic, one out of five attended. One reason for so great difference between the two groups is that the polygenic families are, as a rule, a little older than the other families. However, making due allowance for this factor, a much larger per cent of the plural group have attended higher institutions of learning. Remembering the fact that those settlements were chosen which are more or less remote from the centers of higher education, the reader will realize the strenuous efforts that must have been made to attend school. Not all of those that attended school graduated by any means. Every one was counted who had one or more years in high school or college. In Boston, St. Louis, and Baltimore not over six per cent who start in the beginning grades ever complete the high school (1904).

In 1903-4 Utah had a greater percentage of her young people attending high schools than any other state in the Union except Nebraska. It might be stated in passing that Utah stands third in the Union for low percentage of illiteracy, there being only 1.1 per cent of the population that can not read and write when they reach the age of ten. A greater per cent of her children of school age attend school than any other state. It is also known that she spends a larger proportion of her taxes for education than any other state.

[5]These statistics were gathered between the years 1900-1907.



MORMON CITIES IN UTAH

FIGURE 6. Scenes in Provo and Logan, showing the type of towns that have grown up in the desert.

Those Who Have Distinguished Themselves

In getting the number who had distinguished themselves in any honorable way, the standard was put low enough so that nearly every village had one or more distinguished characters. For example, a county superintendent of schools, a lawyer, a doctor, an artist, an inventor, a keen financier, and so forth, were classed as distinguished. As a result it was found that, on an average, one out of 166 of the monogamic group and one out of twenty-seven of the polygenic had made a name for themselves. We must keep in mind that a greater percentage of the former class had reached their majority. The difference would not appear so great were the groups of the same age.

The Moral Standards

We have now completed the comparison—mental and physical—between these two types of offspring. Let us now examine them morally and spiritually. By referring to Table V it will be seen that only fifty-one of the monogamic group, out of a population of 19,916, have been guilty of felony (a penitentiary offense), in thirty-five years[6]. This is one in 390.5. Of the 2,416 in the polygenic group only five have been found guilty of felony, or one in 483. Remember these offenses extend over a period of thirty-five years, a most remarkable record for any community. The records (Bancroft's History of Utah) show that over eigthy per cent of the people in Utah are Mormons, yet they furnished only fifteen per cent of the crime. The United States Commissioner's report (non-Mormon) of the crime in Utah (and of four or five Mormon settlements in southern Idaho) for 1880 and 1882 show that 208 Mormons and 1578 non-Mormons had been arrested for offenses. Yet the Mormons furnished eighty per cent of the population—four-fifths of the people furnished one-eighth of the crime.

But this gives only a negative view of the moral status of the Mormon people. Let us examine a positive phase of their character. The Latter-day Saints, or Mormons, so-called, have about two thousand young and middle-aged men on foreign missions throughout the world.

They are called on missions from two to three years and often longer; these men are expected to support themselves and their families, if they have any, while on their missions. It takes men of faith and courage to make such sacrifices. These men must also be moral, honest men—men free from profanity, tobacco, debauchery, and kindred offenses; they must be men of intellect and spiritual conviction. They must also be free from constitutional ailments, such as consumption, kidney trouble and heart disease. In short they must pass physical, intellectual, moral and spiritual muster. With such a rigorous scrutiny, a very close estimate can be gotten, at least, of the comparative standards of the two classes of the offspring (M and P). During the last twelve or fifteen years, out of 19,916 monogamic issues, 555 have gone on missions, or one out of thirty-six. Of the 2,416 of the polygenous class 248 have been on missions, or one in ten. Here again after making allowance for the relative ages, we still find a difference which indicates that the boy of the polygenic group has something inherent in him which gives a superiority, morally and religiously, over the boy of the other group. The writer has been asked whether or not the offspring of polygenic parents were not held in greater favor because of their origin, and hence more often chosen for missions. He is morally certain that it is not the case, for he never heard such a suggestion arising among the people. In a number of cases he asked bishops if they knew

[6]This does not include those who were imprisoned for polygeny, because these men were arrested and fined on an *ex post facto law*. They may be classed as law breakers but not as criminals.

that they had been choosing more of one class than the other, and in nearly every instance they replied that they had not given that question a thought, but had been wholly guided by the qualification of the men.

Attendance in Foreign Universities

Feeling that the above figures seemed to prove too much, the writer examined the records of students who had gone to institutions outside of Utah. Accordingly the catalogs of ten leading universities of the United States were reviewed. Catalogs of some of the schools were obtained for a period of only two years, some for five and six years, but catalogs from five of the universities were available for ten years back.

Out of the four hundred students of Mormon parentage who attended foreign universities, 288 were of the monogamous group and 112 were of polygenous parentage, or a little more than one to three. Those of indirect polygenous parentage were included with the monogamous group. There is a possibility of these figures being slightly larger or smaller than given here. As the writer knew only a small part of the students, he got most of his information from reliable informants. This ratio agrees very closely with the one obtained in comparing the two types who attended high school and colleges in Utah, for there it was a little less than one to three.

Class P and Class M, in Utah, are roughly in the ratio of one to ten, but for the 23,000 examined, the ratio is as one to eight and one-fourth. The ratio is rather high for the whole state. This indicates that about three times as many of Class P as of Class M pursue higher courses of studies. It has been asked if this great difference in pursuing higher education was due to the P families being better off financially. If they are, they have gained the difference since they entered that form of marriage, for most of the people entered that system in the days of their poverty, when all were poor alike. It has also been asked if the largest men and women did not enter this principle of marriage. Size was not a consideration. The only qualifications that the writer is aware of, were virtue, honor and religious integrity. True, the fool or dwarf, (just as he should be excluded from any system of marriage) was forbidden to perpetuate his species on the polygenic plan.

Public Office

Still curious to know how these two types of offspring compare in public affairs of state, the names of fifty were obtained. They were men who had held state and national offices since Utah's statehood (1896). Seven of these were non-Mormons; fifteen were of polygenic and twenty-eight of monogamic birth. In this case the ratio was about one to two, or over four times as many of class P (per hundred) held offices as Class M. If the names of all the officers had been available, it would possibly be found that the ratio was nearer to one to three as it is found elsewhere.

Conclusion

This is, in brief, the summation of the work that occupied the writer's attention every spare moment for nearly seven years. His investigations were made with a view of knowing the truth concerning the Mormon offspring of which there has been so much said, and written — accusations and rebuttals, charges and counter-charges—until the people were covered with the calumny of their accusers.

He was so careful that no prejudice should enter the work, that his informants were kept in ignorance of his purpose until he had gotten the data desired. Whenever he handed the small slips for instructors to mark the student's intellectual standing, he requested that they should not look for the student's origin. In many instances he kept the slips himself reading the names and asking the instructors for the student's ability in his classes.

You may ask for a cause of the

startling results from such marriages. To your inquiry the writer may say that he has but little data on the subject; yet in brief, the cause, in part, may be accounted for by the fact that it was due to noble men and women who entered this principle—women who sought noble companions and longed to bear the souls of men into the world. They loved them into the world and blessed their coming. In keeping with this thought a professor said: "It is quite evident that your noblest men and women have entered that principle."

TABLE I—*A Comparison of General Averages of Students of Polygenous and Monogamous Origin*

	GIRLS					BOYS			
Class	Age	Height (Inches)	Weight (Lbs.)	School Rating Per Cent	Class	Age	Height (Inches)	Weight (Lbs.)	School Rating Per Cent
M	17.91	66.24	122.62	83.61	M	21.55	67.2	151.68	83.61
P	19.16	65.88	130.64	88.13	P	20.66	70.32	159.57	90.49
IP	18.26	64.44	128.84	86.73	IP	19.65	68.52	148.22	85.50

TABLE II—*Age of Boys and Their Relative Measurements.*

Ages	*Measure*	*M height ft., in.*	*P height ft., in.*	*IP height ft., in.*	*M weight lbs.*	*P weight lbs.*	*IP weight lbs.*
15	Ave.	5- 6.2	5- 3.8	5- 8.83	119.4	125.86	146.67
	A. D.	1.8	2.5	1.67	18	13.83	4.33
16	Ave.	5- 5.87	5- 7.9	5- 7.2	131.3	139.5	134.64
	A. D.	2.37	1.67	1.63	8.42	2.56	9.1
17	Ave.	5- 8.25	5- 8.6	5- 7	141.87	140.6	138.09
	A. D.	2.3	3.0	1.6	15.69	18.0	7.9
18	Ave.	5- 9.72	5- 8.85	5- 8.55	149.4	146.33	147.4
	A. D.	1.72	2.83	2.66	10.18	9.44	10.13
19	Ave.	5- 8.66	5- 9.42	5- 8.83	149.85	159.87	151.54
	A. D.	2.1	2	1.75	1.39	17.54	13.04
20	Ave.	5- 9.55	5-10	5- 8.44	153.7	158.11	154.0
	A. D.	1.73	2.36	2.19	1.04	16.11	17.18
21	Ave.	5- 9.23	5- 9.67	5- 9.36	156.26	158.67	158.2
	A. D.	2.0	1.5	2.8	1.22	13.83	15.0
22	Ave.	5- 9	5-10	5- 8.5	156.31	160.2	154.84
	A. D.	2.7	1.62	1.83	14.56	10.3	12.17
23	Ave.	5- 9.67	5- 9.33	5-10.2	159.0	160.25	159.4
	A. D.	2.75	1.67	2.6	10.47	10.75	11.2
24	Ave.	5- 8.61	5- 8.6	5- 8.89	161.92	157.4	158.8
	A. D.	2.23	2.4	2.67	9.77	11.00	22.11
25	Ave.	5- 6.45	5-11.14	5- 9.33	148.33	160.43	173.0
	A. D.	1.33	1.22	2.0	9.33	11.58	15.33
26 and up	Ave.	5- 8.84	5-10	5-11	157.34	161.5	163.5
	A. D.	2.65	2.5	.8	13.72	8.17	12.8

TABLE III—*Age of Girls and Their Relative Measurements.*

Ages	*Measure*	*M height ft., in.*	*P height ft., in.*	*IP height ft., in.*	*M weight lbs.*	*P weight lbs.*	*IP weight lbs.*
15	Ave.	5- 4.22	5- 4	5- 4.2	110.0	111.5	122.6
	A. D.	1.11	2.0	2.0	8.33	15.5	12.2
16	Ave.	5- 1.5	5- 5.23	5- 4.26	115.81	121.23	117.56
	A. D.	2.43	3.3	1.3	5.0	12.7	9.04
17	Ave.	5- 4.9	5- 5.6	5- 4.15	121.35	127.8	125.5
	A. D.	1.67	1.67	2.0	10.6	11.2	7.86
18	Ave.	5- 5.57	5- 4.5	5- 5.3	128.8	126.83	130.5
	A. D.	1.72	1.74	1.28	11.43	9.9	12.28
19	Ave.	5- 5	5- 4.5	5- 4.6	132.2	125.9	125.99
	A. D.	1.99	2.1	1.8	11.74	10.3	10.35
20	Ave.	5- 4.7	5- 5.5	5- 6.5	133.3	130.5	138.9
	A. D.	2.5	2.2	1.7	15.0	11.7	11.5
21	Ave.	5- 4.1	5- 7.9	5- 4	125.7	139.62	122.0
	A. D.	1.58	2.38	1.38	7.5	9.62	9.39
22 and up	Ave.	5- 5	5- 7	5- 5.2	128.5	141.0	133.2
	A. D.	2.49	1.99	1.4	12.62	16.2	11.4

TABLE IV—*Average Intellectual Standing of the Students Given in Percentages*

BOYS

	M	*P*	*IP*
Mode	85.83	92.82	86.7
Median	84.71	89.20	86.0
Average	85.57	88.74	86.7
A. D.	6.13	6.71	5.3

GIRLS

Mode	85.5	89.81	87.81
Median	84.41	87.80	86.4
Average	85.96	88.8	87.23
A. D.	6.53	5.7	4.85

TABLE V—*Measurements of Students*

Students from Utah (Class M)					Students from Boston, St. Louis, Oakland, etc.			
	Boys		Girls		Boys		Girls	
Ages	Height (in.)	Weight (lbs.)	Height (in.)	Weight (lbs.)	Height (in.)	Weight (lbs.)	Height (in.)	Weight (lbs.)
15	65	119.4	64.00	110.5	62.9	107.4	61.6	106.7
16	65.87	131.3	63.12	115.81	64.9	121.0	62.2	112.3
17	67.88	141.87	64.9	121.35	66.5	No Record	62.7	115.4
18	68.94	149.4	65.57	128.80	67.4	No Record	No Record	114.9

TABLE VI

	Kinds of Families	
	Monogamic	Polygenic
Number of families (each wife and her children are counted as a family)	3,680	481
Number of living offspring	19,916 (75.7 %)	2,416 (80.6 %)
Number of children physically or mentally defective	166 (00.83%)	14 (00.58%)
Number who have attended higher institutions of learning	787 (3.95%)	450 (18.6 %)
Number who have distinguished themselves	120 (00.6 %)	86 (3.5 %)
Number of criminals. (Those guilty of a penitentiary offense in the last 35 years)	51 (00.26%)	5 (00.2 %)
Number who have been on foreign missions in the last 12 or 15 years	555 (2.8 %)	248 (10.26%)

TABLE VII *Questionnaire blanks used in obtaining information regarding physical and mental standards of the Mormon people.*

BLANK No. 1

1. Name in full.....
2. Height..... 3. Weight.....
4. Religion..... 5. If you are of Mormon parentage, are you of polygenic origin? If so, answer "yes", if not, answer "no." If your parents, one or both, were born in that principle but do not live it, answer "yes, Ind."
6. Intellectual standing (gotten from school records).....

BLANK No. II

1. Name of town..... 2. No. of monogamic families.....
3. No. of monogamic offspring (give number living).....
4. No. of polygenic offspring (give number living).....
5. Give number of children in polygenic families (if ten children were born and four died, put it 4—10, etc..... 6. Give the total children born and dead in three or four times as many monogamic families as there are polygenic families.....
..... 7. Give number of lame, halt, deaf, dumb, cross-eyed, blind, dwarfed, demented, etc., of monogamic offspring.....
.....
8. Give number of lame, halt, deaf, etc., etc. (as above), of polygenic offspring. (If through accident do not count them).....
.....

Eugenics in Congress

Tax discriminations to combat race suicide and stimulate the Rooseveltian idea of larger American families was a new departure in legislation advanced by Representative John J. O'Connor, Democrat, of New York, today.

Represenative O'Connor submitted his proposal in an open letter to Chairman Green, of the House Ways and Means Committee. He urged an amendment to the section of the Mellon tax reduction bill dealing with exemptions for dependent children.

For one child the exemption would remain at $400. For the second child the exemption would be $500, for the third $600, increasing by $100 for each additional child.

"The theory back of this provision," Representative O'Connor said, "is that this is some return to the individual who is maintaining future citizens of the Republic, and will ease in some degree the burden of supporting the normal-sized families. The service of adding to the future manpower of our country is rendered by those maintaining larger families and it is they who should have their tax burdens lightened."

The Cummings Bill

In the midst of the Senate debate on Teapot Dome yesterday afternoon (Jan. 31, 1924), Senator Cummins of Iowa introduced a bill to remove the old Comstock prohibition of the circulation of contraceptive knowledge and introduce a new section to safeguard the circulation of proper contraceptive knowledge by requiring certification by at least "five graduate physicians lawfully engaged in the practice of medicine."

The bill is successor to the Cummins-Kissell bill in the last Congress. The measure was initiated by the Voluntary Parenthood League, of which Mrs. Mary Ware Dennett is director. The bill contains no attempt to solve the birth-control question, which is considered by those backing the bill to be a matter for individual decision. It simply legalizes access to birth-control knowledge and removes the subject from the obscenity statutes.

—*Washington Star.*

ANOTHER INSTANCE OF DEFECTIVE ENDOSPERM IN MAIZE*

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NORMAL AND DEFECTIVE GRAINS FROM SELF-POLLINATED EAR OF MAIZE

Figure 7. The defective grains appeared in a strain of Leaming corn which had been isolated by two successive self-pollinations. The under-sized seeds produced the dwarf plants shown in Figure 8. Little is known about the effect of these recessive defects on development when they are in the heterozygous condition, but it is thought that the elimination of such characters should improve the yield of the varieties now being grown.

ONE of the outstanding facts that maize breeding of the last two decades has revealed is the relatively large number of recessive characters which when isolated in a homozygous condition interfere with the efficient functioning of the corn plant as an organism but which nevertheless are carried indefinitely in a heterozygous condition. As yet there is little data which show what effect these same characters, when heterozygous, have on the ontogeny of maize. It would seem that the elimination of such characters would result in the improvement of corn, considered from the standpoint of production. At any rate much of the present corn breeding is carried on with a view of eliminating certain characters which are decidedly undesirable when homozygous.

One of the characters of this nature

*Approved by the Director of the West Virginia Experiment Station, Scientific Paper No. 6.

DWARF PLANTS FROM DEFECTIVE SEEDS

FIGURE 8. Plants from normal and defective seeds, shown in Figure 7, ten weeks after planting. Several of the defective plants were so weak that they died prematurely.

has been called defective seeds. From the genetic analyses made and the descriptions given, [1 2 3 4 5] † it is certain that there are several different kinds of defective seeds. The present brief paper describes and gives some evidence regarding the inheritance of a defective endosperm which was discovered in a self-fertilized strain of corn.

Source of the Defective

During the summer of 1920 an experiment which involved inbreeding several different varieties of corn was begun. One of the varieties used in this investigation was Leaming, which was obtained from George S. Strosnider near Waynesburg, Pa. In 1922 there were grown from this variety twenty-three strains which had been isolated by two successive self-pollinations. One of these strains produced a selfed ear which showed segregation for endosperm development. On the ear were 284 normal and 96 abnormal seeds. Six selfed ears were matured by this strain but only one had both normal and abnormal seeds.

Description

The seeds which showed defective development were undersized. In some cases growth seemed to have been arrested before one-half of the endosperm was laid down, in other cases growth apparently did not cease until later. The defective seeds could be distinguished also by their milky appearance and slightly wrinkled pericarp, particularly near the crown. The normal seeds were corneous and had a distinct lustre. Figure 7 illustrates the two types of seed.

In 1923 the normal and abnormal seeds were planted separately. The former produced normal plants but the latter produced plants which were

†Numbers refer to "Literature cited" at end of article.

stunted and slender and which were somewhat later in maturing than the normal plants. Several of the individuals from the defective seeds were so weak that they died prematurely. Figure 8 illustrates the difference, ten weeks after planting, between the plants produced by the two types of seeds.

Inheritance

Most of the normal plants were self-pollinated. One hundred and fifty-three ears which matured sufficient seed to classify them definitely and which represented as many different plants were obtained from these hand-pollinations. Of this number ninety-eight ears showed segregation for normal and defective seeds and fifty-five ears produced normal seeds only. A few of the plants from defective seeds produced small ears. It will be recalled that the parent ear had 284 normal and 96 defective seeds. The inheritance of this defective endosperm is apparently controlled by a single factor difference.

Whether the endosperm defect reported here is or is not identical with some already described by other investigators may be determined by appropriate genetic analyses.

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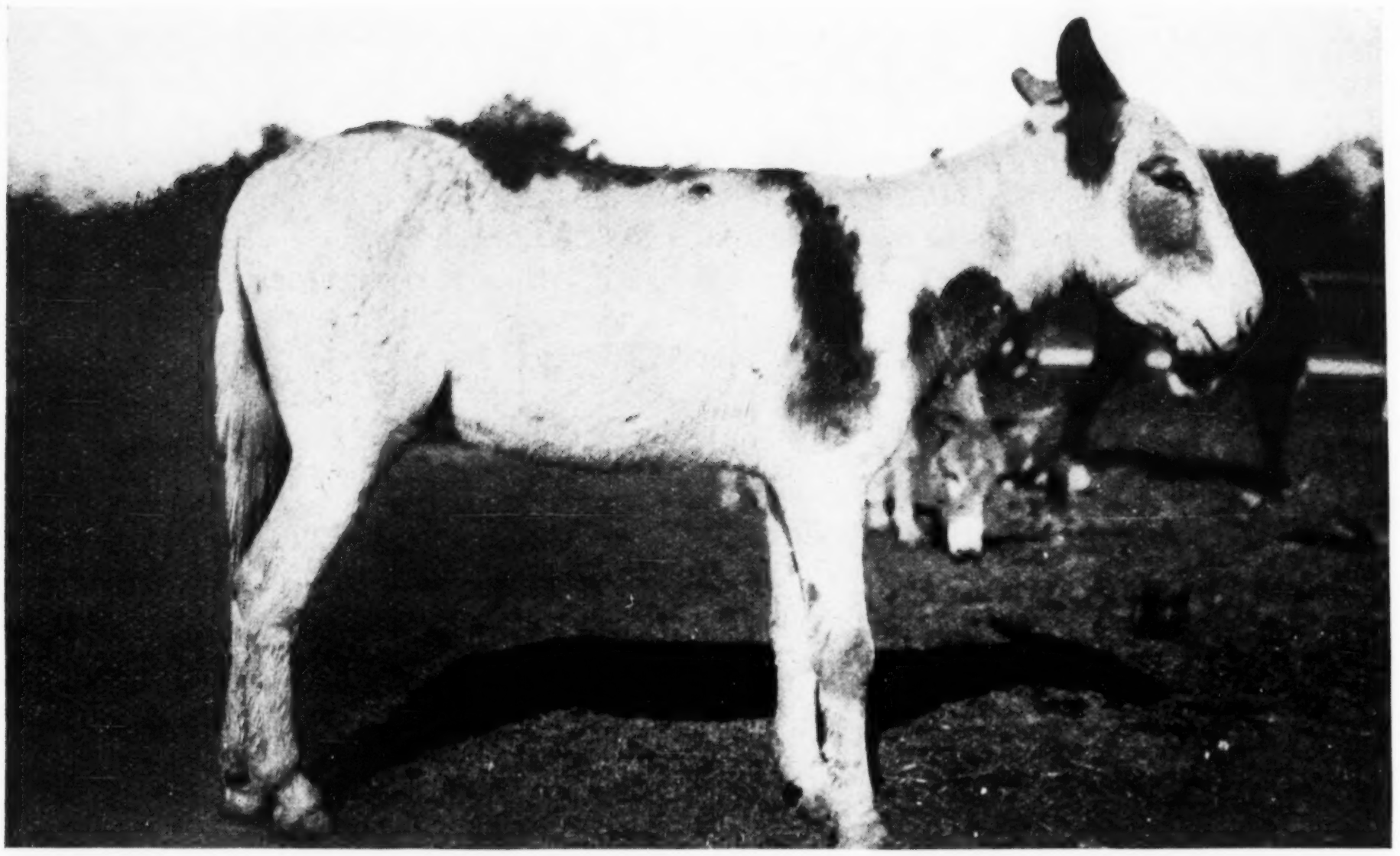
Marry Early, Work Hard, Eliot Urges

Service to country, joy in work and early marriage were enjoined upon Harvard undergraduates by President Emeritus Charles W. Eliot in an address to students which brought to a close the public tribute to the aged educator in honor of his ninetieth birthday.

"Serve the country," he said, "serve her in peace as well as in war, serve her by sacrificing money, for example, high professional earnings, in order to take public office, elective or appointed office.

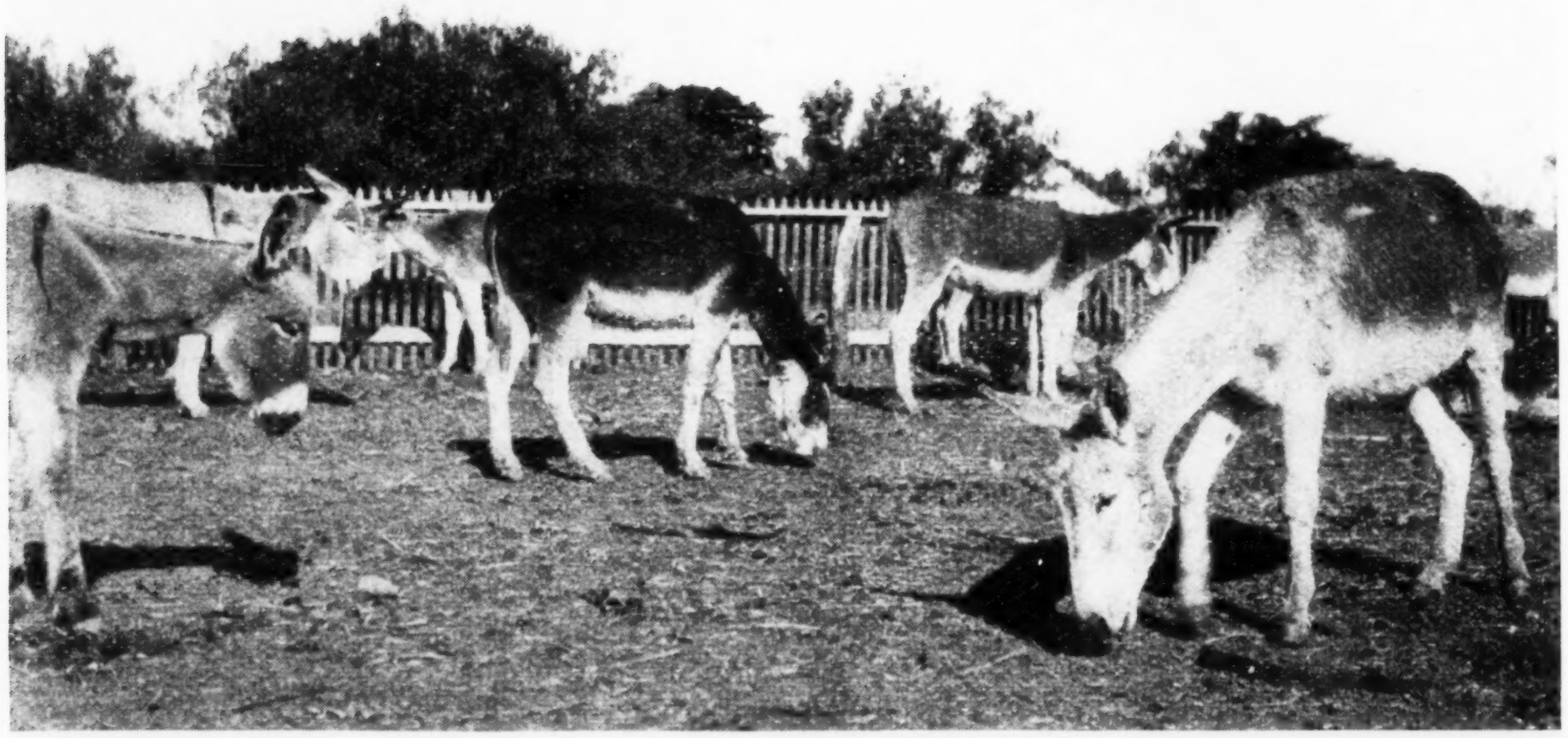
"Use the opportunity of selecting studies which you have at Harvard to find out while you are here in what work, in what profession you can find joy in your work all your life. The chief satisfaction of my life has come out of joy in work.

"Do not put off marriage too much. Do not wait until you think you can offer the girl you want to marry all the luxuries and privileges to which in her father's home she was accustomed. When you have made up your mind give the girl a chance to tell you hers."—*Associated Press.*



SIRE OF THE "PINTO" FOAL

FIGURE 9. The red and white or "calico" pattern is common among horses, but this is the first time it has been observed among burros. The cross between the horse and the burro produces a mule, generally an infertile hybrid. A few authentic cases of fertile mules have been reported and such an individual might explain the origin of the "pinto" burro.



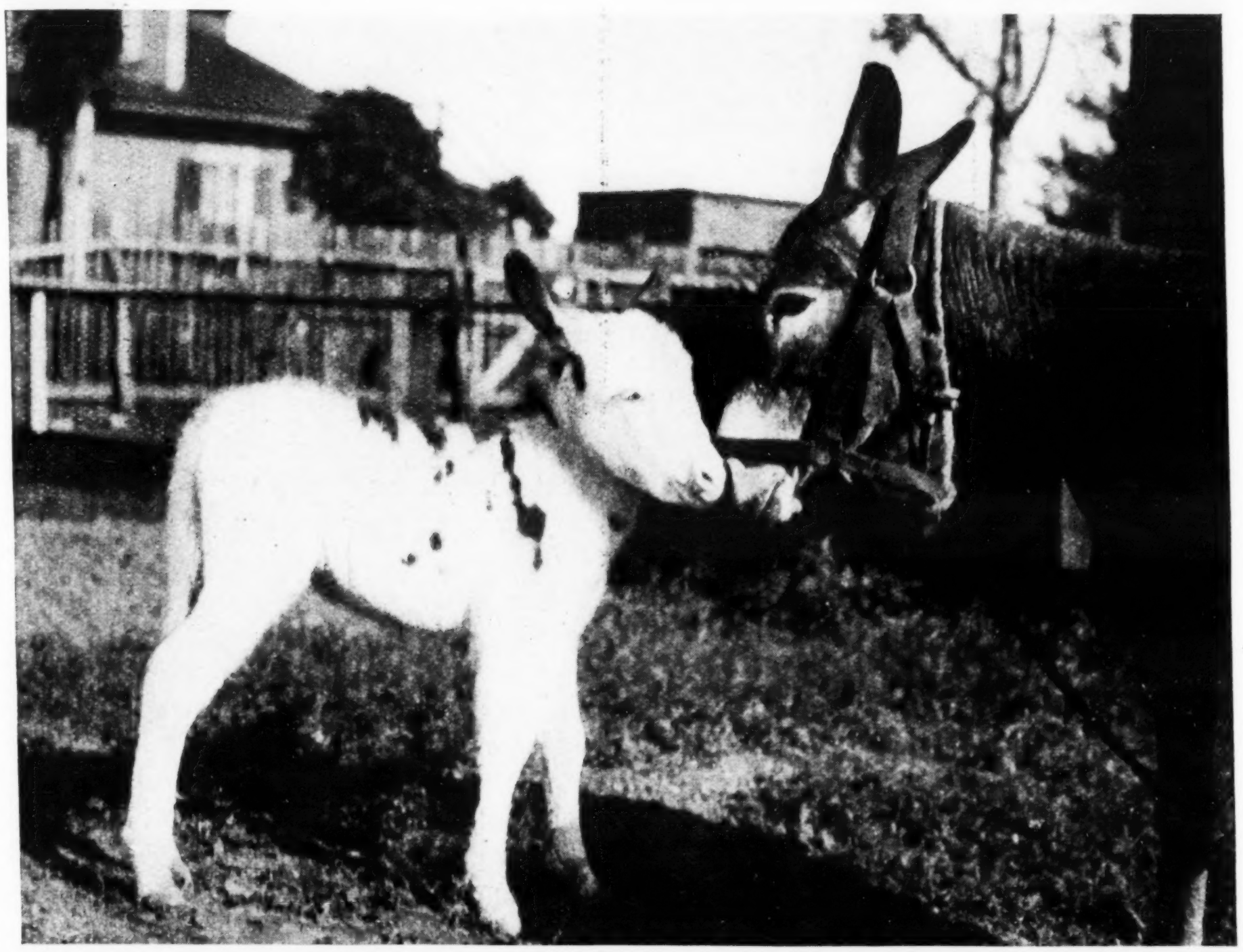
TYPICAL BURROS

FIGURE 10. White, black and their intermediate shades are typical of the burro. The pinto varient is said to have originated on a ranch in Mexico, where there are many other individuals of this unusual color.

THE "PINTO" BURRO

T. C. Richardson

Lyford, Texas



"PINTO" COLOR A DOMINANT CHARACTER

Figure 11. The dam of this week-old fold is a typical dirty black burro, and its sire is shown in Figure 9. Among the thousands of wild burros found on the plains of Texas not a single case of "pinto" marking has been observed, which strengthens the view that this unusual color is inherited as a Mendelian dominant character.

HERE is a problem in genetics, interesting, but not easily explained by any known facts. A race of "pinto" burros, of which two specimens have been found north of the Rio Grande, is said to have originated somewhere in Mexico.

The two pinto animals shown in the photographs are sire and offspring. They were found in a herd being assembled at Brownsville, Texas, for shipment to other sections, and their peculiar coloring attracted much attention. The writer was unable to secure more definite information about their origin than that on a ranch in Mexico there were many "pintos" similar to these.

The coloring is nearly pure white, with sorrel splotches. Since the basic colors of the entire donkey family are white and black with their intermediate shades and mixtures, the question arises as to where these "pintos" received the red. Among thousands now running wild on the

coastal plains of Texas there is never seen a specimen showing other than the usual "burro" colors, ranging from gray to brownish black.

Is this "pinto" race of burros the product of interbreeding, as suggested in the November National Geographic Magazine in the discussion of the Mustang pony or must we look elsewhere for the origin of the piebald donkey? Among the Indians of the Southwest, pinto ponies have always been plentiful, and while not so common as with the Indians, they are well distributed in Mexico.

Whether the pinto pony was the result of interbreeding of animals of other colors is scarcely a debatable question, for in the horse family the colors going to make up the pinto have been known for ages, but since the reds do not occur in the ass family, it would appear necessary to look elsewhere for an explanation of the "calico" burro.

The theory may be advanced that this phenomenon is the result of a cross between the pinto pony and the ordinary light gray burro. The tenability of this theory, of course, depends upon the hypothesis that such a hybrid may have proved fertile, an unusual, but not an unknown phenomenon. The A. and M. College of Texas has within the year been exhibiting a mare mule with foal, one of the few well-authenticated cases of the kind.

The theory may be strengthened by the fact that the jackass in question shows considerably shorter ears than is usual in his race. Close observation failed to reveal any other indications of horse blood, outside the fact that the red of the spots is the typical sorrel red so common in the mustang. Granting the possibility of hybridization and its reproduction, of course a few generations of continued breeding with the *equus asinus* side of the cross would tend to obliterate more and more of the characters resulting from the *equus caballos* blood.

The dam of the week-old foal is of the typical dirty black burro color, and her ears are as long as those of the average donkey, as will be seen by referring to the picture. The dominance of the white-and-sorrel coloring is indicated by the fact that the foal shows none of the brown or black characteristic of the donkey family.

Native White Population Outnumbered by Foreign Born

Detroit's American-born white population is being outdistanced in race multiplication by the foreign-born families which have come to the city, according to Dr. Carl E. Buck, of the Department of Health. The following table indicates the problem:

Nationality	*Birthrate*
Italian	6.8
Polish	5.1
Austrian	4.5
Greek	4.1
Russian	3.2
Belgian	3.0
Scotch	1.9
American	1.2

—*Detroit Educational Bulletin.*

THE GENETICS OF MULTI-NIPPLED SHEEP

An Analysis of the Sheep-Breeding Experiments of Dr. and Mrs. Alexander Graham Bell at Beinn Bhreagh, N. S.

W. E. Castle

Harvard University.

IN a recent number of this *Journal* (June, 1923) was published posthumously a brief account by Dr. and Mrs. Alexander Graham Bell of the sheep-breeding experiments which they had carried on for more than thirty years at Beinn Bhreagh, Nova Scotia, with the object in view of producing a breed of sheep which should be multi-nippled and twin-bearing. Dr. Bell kept with scrupulous care orderly and systematic records of the experiments. These it has been my good fortune to examine through the kindness of Dr. David Fairchild, who entrusted them to me with the request that I express an opinion on the heritability of the characters, supernumerary nipples and multiple births, and the desirability of continuing the experiments for their scientific interest. The report which I prepared was not intended for publication but inasmuch as it deals with a notable and extensive selection experiment, I gladly comply with Dr. Fairchild's request to submit it for publication in a slightly modified form.

The records show in the case of each lamb, its color, sex, the number of its nipples and whether it was born as a single or a twin. The same facts when known are recorded for each of its parents. These records down to and including the year 1903 were printed in a "Sheep Catalogue" by Dr. Bell in 1904 and were distributed by him to fellow members of the National Academy of Sciences and to other interested persons. The records from 1904 to 1923, inclusive, are on typewritten sheets.

From an analysis of the records the following conclusions have been reached:

1. *The character, supernumerary nipples,* by which is meant the possession of more than one pair, *is strongly inherited.* According to Dr. Bell's records, about one in five of the sheep on Beinn Bhreagh when the place was acquired by him bore two pairs of nipples, one pair well developed, the other rudimentary. This is a common occurrence in various breeds of sheep, perhaps in all, but Dr. Bell was apparently the first to inquire into the significance and possible heritability of the extra pair. It occurred to him that it might be possible by selection to improve this condition to resemble that of the cow, which has regularly four well-developed functional teats, often with one or two rudimentary ones in addition. With this idea in mind he selected as breeders those sheep which had the largest number of nipples and in consequence the average number of nipples increased in the flock from year to year. See Table I. Although at first only about one ewe in five had an extra pair of nipples, by 1894 practically all ewes with a smaller number had been discarded and two ewes had been purchased which had six nipples each. From this time on no rams were used which had fewer than four nipples. In 1910, the standard for ewes was raised to six nipples, a point attained for rams eleven years earlier. The lambs averaged 2.27 nipples each in 1890. Two years later the average had advanced to 3.14; by 1896 it was 4.18; in 1909, it was 5.00; and it reached a maximum at 5.40 in 1913, a point not surpassed and equalled only once in the remaining ten years of the experiment to date. Although no two-nippled ewe was bred subsequent to 1894 (except in 1904, when a cross

was made with two-nippled Dorset ewes), nevertheless an occasional two-nippled lamb was produced as late as the year 1916, but the majority of the lambs resembled their parents in having four or more nipples. Further than this, there was a close agreement between the modal (or commonest) number of nipples among parents and offspring. When the standard for parents was advanced to four, this became straightway the modal number for the offspring, and later when the parental standard was advanced to six, the modal number for the lambs also became six.

Four-nippled sheep were already present in the flock at the beginning of the experiment. By simply discarding all others, the flock was made exclusively four-nippled and the lambs born in it were predominantly so from this point on. But no six-nippled lambs were produced by this purely negative selection. They came from an outside source. In 1891 Dr. Bell purchased a six-nippled ewe born the previous year, and in 1894 he purchased another born in 1892. Up to this time no six-nippled lamb had been born in the flock and none was born until 1896. That lamb and all other six-nippled lambs born subsequently in the flock were descended on one or both sides of their ancestry from one or the other or both of the purchased six-nippled ewes. It is clear, therefore, that the six-nippled condition was not created in the flock by selection, but introduced ready made from outside, a probably fortuitous variation of higher grade than those which the foundation stock happened to include.

2. *The particular grade of multi-nippled condition borne by the parents is as a rule inherited by the offspring.* This is shown by tabulating the nipple condition of the lambs in relation to that of their parents, as shown in Tables II. and III. With every increase in number of nipples borne by the parents there is a corresponding increase in the nipple number of their offspring, but with slightly increased regression as the departure from the normal of the race increases. That normal seems to lie between two and three nipples, for two-nippled parents produce lambs with a slightly higher average number of nipples, namely 2.22, the regression being *upward*. With 4-4 parents the regression is downward and amounts to .26, with 5-5 parents it is .62, and with 6-6 parents it is .77. These are the figures derived from a study of the general flock which was maintained from 1890 to 1914, inclusive. See Table I. In 1914 the flock was subdivided. Into Davidson's flock went the best of the six-nippled sheep, none of lower grade being selected. Into Mrs. Bell's flock went some of the sheep having four to six nipples and with a good record for producing twins, which was made a major point in the management of this flock. Notwithstanding the highly selected character of the parents in Davidson's flock, the average nipple number of the lambs was no higher than it had previously been in the general flock from parents of like grade. In the general flock the average for lambs of 6-6 parentage was 5.23; in Davidson's flock it was 5.20; in Mrs. Bell's flock it was substantially the same, namely, 5.19.

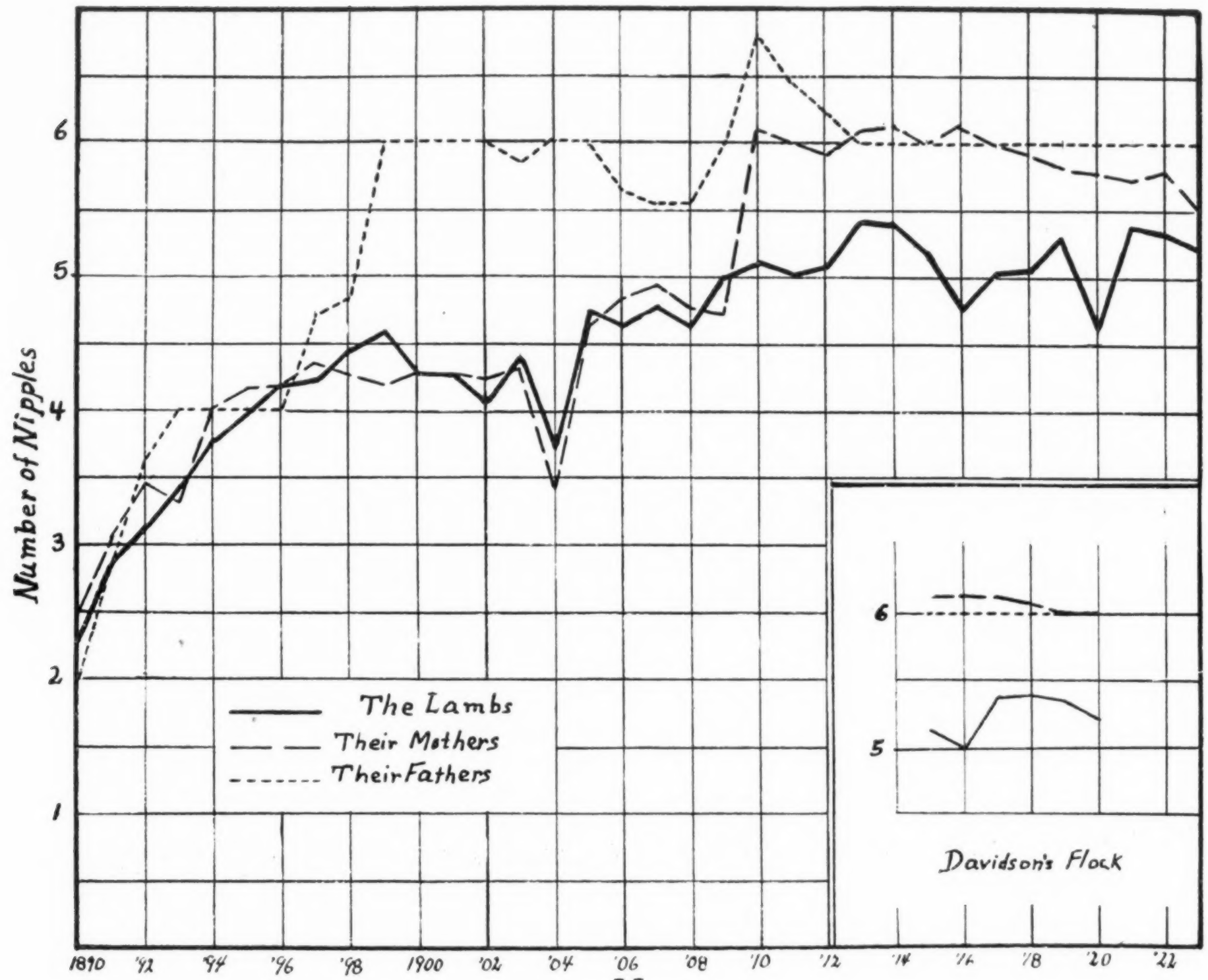
3. Very few lambs were produced with a higher nipple number than six. In 1906, an eight-nippled lamb was born to 4-5 parents of six-nippled ancestry, and in 1909 another eight-nippled lamb was born to 6-6 parents. During the same period four seven-nippled lambs were born, and subsequently seven others were recorded in Davidson's and Mrs. Bell's flocks. But matings of seven and eight-nippled parents produced only one lamb which had more than six nipples, that one being a seven. Apparently, in isolating a six-nippled race selection had accomplished about all that could be accomplished in the direction of increased nipple production. Nevertheless, it is to be observed that alike in the general flock (Table II.) and in the flocks of Davidson and Mrs. Bell, 6-7 and 6-8 matings produced lambs of higher average

nipple number than did 6-6 matings, so there can be no doubt that the seven and eight-nippled individuals marked a genetic as well as a somatic advance in nipple number. But advance in nipple number was evidently becoming increasingly difficult, as is usual in selection experiments dealing with quantitatively varying characters.

4. The degree of development of the supernumerary nipples and the extent to which they produced milk is not mentioned in the records except in connection with Mrs. Bell's flock, and here very little exact information is available. Dr. Bell, in the published report, states that in the ewes retained for Mrs. Bell's flock "in nearly every case the supernumerary mammæ were small and not functional in adult life." Presumably this had been true in the general flock up to that time. In Mrs. Bell's flock it was now made a special object to obtain two pairs of functional, milk-yielding nipples. By a search among the flocks of farmers who had in previous years bred from Dr. Bell's multi-nippled rams, sixteen ewes were found in which a secondary pair of nipples was well developed and had evidently been sucked by the lambs. These ewes were purchased and when they produced lambs of like character these were incorporated in Mrs. Bell's flock. A majority of the lambs born in Mrs. Bell's flock were descended from these purchased ewes. A record has been found for the nipple condition in the lambs of Mrs. Bell's flock only for the year 1919, the entry, in Dr. Bell's own handwriting, being dated September 6, 1919. In thirteen ewe lambs examined on this date, all but one trace back to purchased ewes as mothers or grandmothers. The nipples are ranked as "pass" in one case, as "good" in eight cases, as "fine" in three cases. No comment is made in one case, but a diagram shows two pairs of larger nipples with a smaller pair between them. In the published article Dr. Bell expresses the adopted "principle of selection" thus: "The lambs having four or more well-developed, well-separated nipples of about equal size were retained in the flock." His comments, "pass," "good" and "fine," are probably to be interpreted in the light of this "principle." They indicate a good degree of success in selecting the well-developed and presumably functional nipples. We are warranted, therefore, in supposing that immediate success follows an attempt to select for better degrees of development of the nipples, exactly as it had attended selection for a larger number of nipples in the history of the general flock.

5. It remains for future investigations to show whether with increase in the number of functional nipples an increase occurs also in the total amount of milk produced. There is nothing in the records to show whether or not such an increase has occurred in Mrs. Bell's flock. Certain general considerations would not favor the idea. The domestic animals which are most useful for the production of milk are those with a restricted number of functional nipples; the cow has four, the mare two and the goat two. Cows and goats vary enormously in capacity to produce milk without any variation in number of functional nipples. It is doubtful whether mere variation in number of nipples would affect materially the quantity of milk produced. For it is known to dairymen that one nipple or "quarter" of the cow's bag may cease to function in consequence of milk fever or some other mischance, yet there is no corresponding loss in total milk production because compensatory hypertrophy of the three remaining mammæ occurs. There is little reason to doubt that sheep could be successfully selected for increased milk production, just as cattle and goats have been, but there is ground for skepticism as to whether mere increase in number of functional nipples would necessarily result in increased total production of milk.

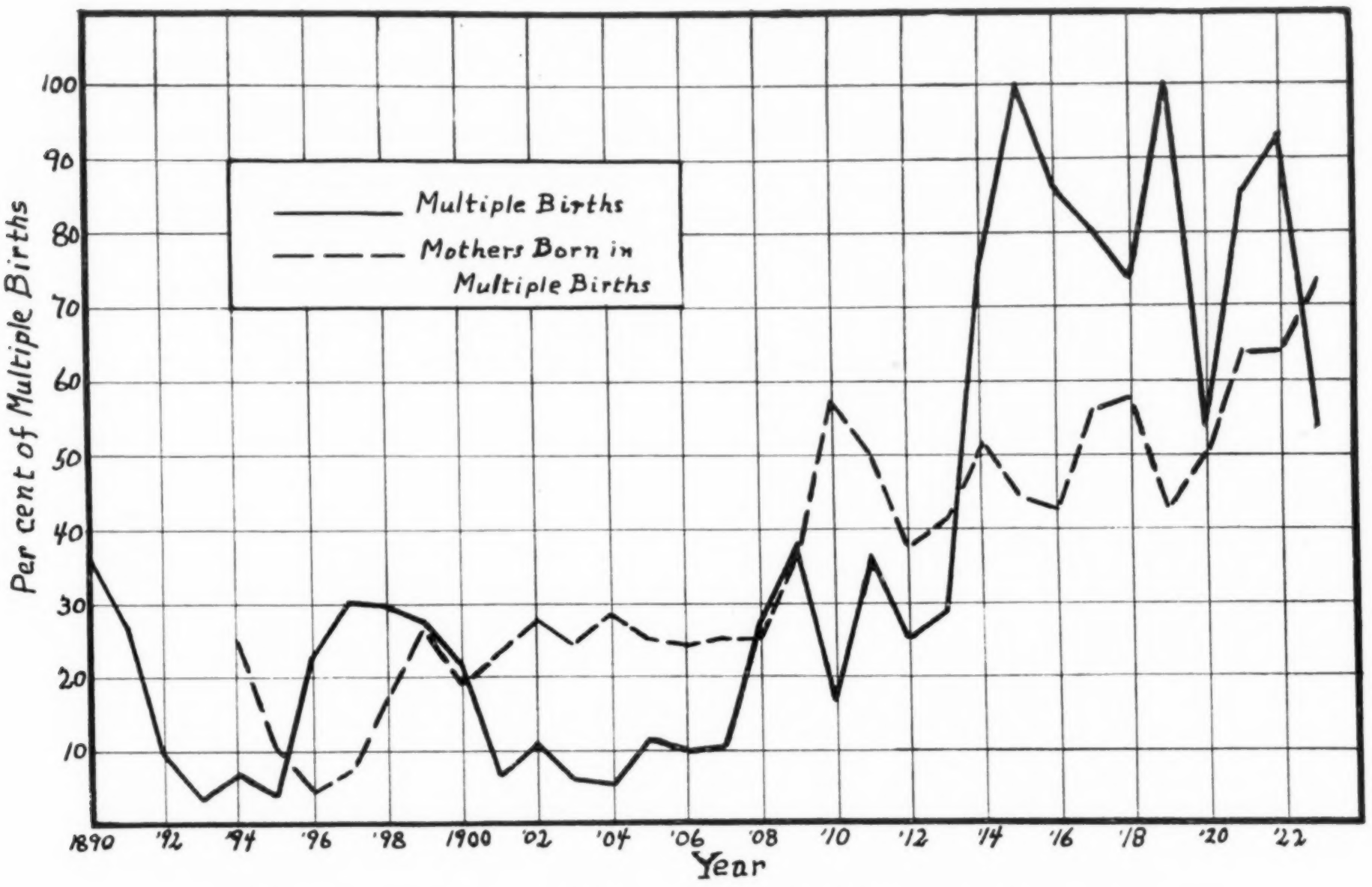
6. To utilize the multi-nippled condition in crosses with other breeds of sheep, some knowledge of its mode of inheritance would be desirable. An indication of this is given by a cross



YEARLY AVERAGE NUMBER OF NIPPLES IN DR. BELL'S FLOCK

FIGURE 12. The solid line shows the average number of nipples for the lambs born each year from 1890 to 1923; the broken line shows the average number for their mothers, and the dotted line the average for their fathers. The increase in number of nipples was brought about by introducing six nippled stock from outside and not by purely negative selection within the flock.

made by Dr. Bell in 1904-7 between Dorset ewes having either two or four nipples each, and six-nippled rams born and used in the general flock. The two-nippled Dorset ewes had 4 two-nippled, 2 four-nippled and 1 five-nippled lambs, an average of 3.0 nipples. The four-nippled Dorset ewes had 2 two-nippled, 2 three-nippled, 9 four-nippled and 2 five-nippled lambs, average 3.73 nipples. In each case the number is either intermediate between the parental numbers or lower than either parental number, indicating regression toward the normal number, 2. The result of this cross was so discouraging in its effect on the nipple number that no second generation was produced. A single F_1 ewe (1806) was back-crossed with a six-nippled ram, producing a pair of twins, both three-nippled. One of the five-nippled F_2 rams (1502) was bred quite extensively in the years 1907-8. By four-nippled ewes he sired 26 lambs, 1 three-nippled, 21 four-nippled, 3 five-nippled and 1 eight-nippled. The only other eight-nippled lamb ever produced in the flock was a grandson of this same ram, which fact is perhaps significant. The average nipple number of his 26 lambs by four-nippled mothers was 4.23, which agrees very well with the general average for all 4-5 matings, which was 4.31



PERCENTAGE OF MULTIPLE BIRTHS EACH YEAR

FIGURE 13. The per cent of multiple births each year is shown in the solid line, and the per cent of mothers born in multiple births is shown in the broken line. The data do not indicate that heredity plays much part in determining the number of multiple births. The principal factor appears to be the state of nutrition of the mother. English shepherds recognize this fact and regularly feed the ewes abundantly during the breeding season to increase the percentage of twins.

(Table II). By five-nippled ewes this ram (1502) had thirteen lambs, of which nine were four-nippled, three five-nippled and one six-nippled, average 4.38, which is exactly the average for all 5-5 matings combined. By six-nippled ewes, this ram sired six lambs, of which two were four-nippled, three five-nippled and one seven-nippled, average 5.00, which is rather better than the general average for 5-6 matings (4.69, Table II). He seems to have bred very much as other males with the same somatic character, except that he produced an occasional unusually high-grade individual (seven or eight-nippled). This suggests possible recombination of factors as a result of the cross.

On the whole it appears that the normal low nipple number has a tendency to dominate in crosses, but that a first-generation hybrid somatically high in nipple number is also genetically high, and that the progeny of such an individual may even transcend the usual range of nipple number in the uncrossed races. Thus by crossing multi-nippled families in different breeds of sheep a race of still higher grade in nipple number might be secured. What is true of nipple number might conceivably also be true of functional performance of the supernumerary nipples.

Twining Not Hereditary

7. The second major object in this sheep-breeding experiment was to increase the proportion of multiple births so that twins would be produced regularly, not occasionally as in the foundation stock. The incidence of twin births in the flock's history is shown in Table III. The first year of record, 1890, shows a large amount of twinning, more than one-third of the ewes

bearing twins. Only once in the next twenty-three years did the flock produce as high a proportion of twin births. During this period the percentage of multiple births varied between limits of 3.1 and 37.5. Then suddenly, in the year 1914, it mounted to 76.4 per cent., and subsequently remained high in Mrs. Bell's flock and usually so in Davidson's flock. This change did not coincide with any change in the basis of selection. The occurrence of twinning is much more erratic than that of multiple nipples and less clearly due to heredity. See Figures 12 and 13. In fact, the hereditary element in twinning is probably very small while that of environment is large. Throughout the experiment preference was given to parents born as twins, and in the years 1897-1902 no rams were used except those born as twins. Despite the selection for twinning, the frequency of twinning in the flock did not increase prior to 1914.

One circumstance which influences twinning is maturity of the mother. Yearling ewes rarely have twins. Consequently, in Table III births of yearling mothers have been tabulated separately from the others. Four times in the history of the flock yearling mothers have had twins. It is probably not a coincidence that on three of these four occasions an older ewe has in the same year had triplets. The production of triplets by an older ewe is an event about as rare as the production of twins by a yearling. Previous to 1915 only two sets of triplets were recorded. Subsequently eight sets were recorded in Mrs. Bell's flock, which seems to have been especially well nourished, and one was recorded in Davidson's flock. In each of these flocks a yearling ewe had twins in the same year that an older ewe had triplets. It is probable that good nutrition of the flock is reflected in high fecundity of the ewes, a widely held belief among English flock masters, who regularly practice "flushing" at the breeding season. That is, they feed the ewes abundantly on nutritious food previous to breeding them. The food relation probably underlies an observation recorded by Dr. Bell that breeding in October produces more twins than breeding in November or December. Apparently, a change in the seasonal management of the flock was made in 1913, for in 1914 the percentage of multiple births more than doubled and it remained high subsequently in the divided flock known as Mrs. Bell's and Davidson's. Table IV shows that the percentage of multiple births was about the same within each flock irrespective of the condition in which the parents were born, whether as singles or twins, and that the percentage in each flock was characteristically different, owing doubtless to differences in management, since genetically they had in large part a common origin.

It may be suggested that twinning is probably inherent in the mother alone and unaffected by the immediate sire.* Accordingly, in Table V the births are classified with reference to the birth condition of the mother only, births by yearling mothers being omitted as likely to be single irrespective of the usual performance of the mother. This table shows that in the general flock and in Mrs. Bell's flock mothers born in multiple births are a little more likely to produce multiple births than mothers born as singles, but the difference is not great. In Davidson's flock the relation is reversed, mothers born as singles producing more twins than mothers born as twins. But here again the difference is small and of doubtful significance. The slight indicated resemblance betweens mother and offspring as regards multiple births may well rest upon resemblance in general vigor rather than on any specific tendency to twinning. For any agency, whether environmental

*Such is the conclusion of Roberts *(Journal of Agricultural Research* 22:232. 1921), who finds that the percentage of multiple births in Shropshire sheep rises from a minimum of 23 per cent in yearling mothers to a maximum of 46 per cent in six-year-old mothers, but that "we cannot ascribe to the ram any influence on fertility," yearling rams being quite as prolific as older ones.

or genetic, which contributes to a well-nourished state in the mother would probably favor fecundity. An outcross introducing "hybrid vigor" might conceivably act in this way.

Dr. Bell did make two outcrosses, one with merino rams and the other with Dorset ewes. Four of the merino cross-bred ewes had lambs when two or three years old, but these were all singles, indicating no increased tendency to twinning. Eleven pure Dorset ewes, probably as yearlings, all had single lambs in 1904. Only two of them were bred a second time. These two, when aged two years or older, are credited with four pairs of twins, a set of triplets and a single, a very high percentage of multiple births at a time when the flock average was around 10 per cent. If they represent a fair sample of the Dorset race and were treated as a part of the general flock, it seems probable that Dorsets have a higher percentage of multiple births than the general flock of this period. The Dorset cross proved disappointing so far as influence on nipple number was concerned, and only one ewe produced by this cross has recorded offspring. She (1806) as a yearling had twin lambs in 1909, when the general flock showed 37.5 per cent. of multiple births. This was the only occurrence of twinning by a yearling not attended in the same year by production of triplets by an older member of the flock. So far as this evidence goes, it indicates high fecundity in the Dorset cross-breds, either as a character inherited from the Dorset dam or as a result of heterosis, but of course a single case is inconclusive.

To sum up the evidence, it is clear from Tables III-V that heredity has a relatively small influence on the occurrence of twinning in the Bell flock of sheep, but that the major factor is probably the state of nutrition of the mother, which is affected (a) by her age; (b) by the season of breeding, which in turn probably acts through (c) the food supply. It is known that twinning is commoner in some breeds of sheep than in others. In general the more vigorous and rapid-growing breeds of sheep, the so-called mutton breeds, twin more frequently than the fine-wooled breeds, for example the merinos. This is borne out by the different results obtained by Dr. Bell when he crossed his flock with merinos and with Dorsets respectively. It is probable that the only genetic factors concerned in twinning in sheep are those which affect the general vigor of the mother, causing multiple rather than single ovulations.

8. That there is no necessary relation between nipple number and twinning is obvious from a comparison of Figures 12 and 13. Nipple number rises in consequence of selection, but twinning does not, though environmental influences may send it mounting upward regardless of ancestry. This agrees with the finding of Parker and Bullard* for swine. They studied the relation between size of litter among unborn pigs and number of mammæ of the mother and found no correlation.

One other matter on which these experiments throw light is the inheritance of coat color in sheep. Many black lambs were born in the flock and some of these were kept for breeders. In each of the years 1895, 1907, 1908 and 1914, a black ram was used in addition to one or more white rams, and in Mrs. Bells' flock in the years 1915-1917 only black rams were used. We are thus provided with records showing the results of various kinds of matings between white and black sheep and of each sort bred by itself. The matter has been correctly analyzed by Davenport who reports black to be a simple Mendelian recessive to white. In accordance with this interpretation black sheep mated with black should always produce black lambs. An examination of the record indicates that such matings produced twenty-seven black lambs and four white ones. But there is

*Proc. Am. Acad. Arts Sci., 49, September, 1913.

reason to question the correctness of the entries as regards the reported white lambs. They were born to three different mothers, two of them as singles and two as twins. None of the lambs appears subsequently in the records as a parent, so that it is impossible to verify the correctness of the entries. It is possible that they are due to clerical errors but more probably they are due to incorrect determination of the color, owing to premature birth of the lambs, the fact being of course unknown to the recorder that he was dealing with a critical mating.

Numerous matings of white parents are reported as producing only white lambs, which is the theoretical expectation when one or both parents are homozygous for the dominant character, white. Many pairs of white parents produced sometimes a white and

TABLE I. *Number of nipples borne by the ewes, the lambs, and their sires in each year of the flock's history.*

Year	Nipples of the ewes								Nipples of the lambs								
	2	3	4	5	6	7	8	Av.for ewes	2	3	4	5	6	7	8	Av.for lambs	Av.for the sires
1890	52	4	16					2.50	60	4	8					2.27	2.00
1891	36	4	38					3.05	40	9	29					2.86	2.87
1892	19	5	44	2	1			3.45	29	4	37	1				3.14	3.63
1893	22	4	40		1			3.31	15	8	44					3.43	4.00
1894	1		15		1			4.00	1	2	14					3.76	4.00
1895			24		2			4.15		2	23	1				3.96	4.00
1896			24		3			4.19			23	3	1			4.18	4.00
1897			27	2	5			4.35		1	27	3	3			4.23	4.73
1898			30	4	3			4.27			26	5	6			4.46	4.83
1899			36	5	2			4.20		1	26	6	10			4.58	6.00
1900			36	5	4			4.28	1	1	29	12	2			4.28	6.00
1901			26	3	3			4.28			26	3	3			4.28	6.00
1902			41	9	2			4.25		2	41	6	3			4.19	6.00
1903			39	13	2			4.31			36	12	6			4.44	5.85
1904	23		30	8	1			3.42	16	2	30	11	3			3.72	6.00
1905			18	7	6			4.61			14	9	8			4.74	6.00
1906			17	10	11			4.84		4	17	8	8		1	4.63	5.65
1907			13	12	11			4.94		1	18	7	8	2		4.77	5.55
1908			18	8	11			4.77	1		20	7	8	1		4.64	5.55
1909			20	4	11			4.74	1	3	9	7	13	1	1	5.00	6.00
1910					9	1		6.10			4	1	5			5.10	6.80
1911			1		19	2		6.00	1	2	4	3	12			5.04	6.45
1912			2		24	2		5.92	1	2	5	5	15			5.10	6.21
1913					20	2		6.09			3	7	12			5.40	6.00
1914					32	4		6.11		1	5	9	21			5.38	6.00
	Davidson's flock.																
1915					25	4		6.13	2		5	8	13	1		5.13	6.00
1916					25	4		6.13	1		10	5	13			5.00	6.00
1917					16	2		6.11			2	7	9			5.38	6.00
1918					23	2		6.08			3	9	13			5.40	6.00
1919					19			6.00			4	5	9	1		5.36	6.00
1920					14			6.00		2	1	3	8			5.21	6.00
	Mrs. Bell's flock.																
1915					12			6.00			4	2	6			5.16	6.00
1916					14	2		6.12	1		7	3	5			4.75	6.00
1917				2	27	2		6.00			7	17	6	1		5.03	6.00
1918			1	3	26	3		5.94			11	9	13			5.06	6.00
1919			2	4	13	4		5.82			5	6	12			5.30	6.00
1920			2	5	12	4		5.78		2	11	4	6			4.60	6.00
1921			4	3	15	4		5.73		1	4	6	9	3		5.39	6.00
1922			4	4	18	5		5.77		1	4	10	16			5.32	6.00
1923			5	5	15	2		5.51			7	8	11	1		5.22	6.00

sometimes a black lamb; in a few cases one lamb of each kind composes a pair of twins. The theoretical expectation from such matings is twenty-five per cent black lambs.

The best evidence that black is a simple recessive comes from the mating of white rams known to have produced black lambs, and so to be heterozygous dominants, with recessive (black) ewes. Such matings produced fifty-eight white and fifty-seven black lambs, in complete agreement with the expected 1:1 ratio.

TABLE II. *Relation between number of nipples in parents and offspring.*

Number of nipples borne by the two Parents	Average number of nipples borne by the Offspring	Range in number of nipples	Number of Offspring
2-2	2.22	2-4	94
2-3	2.33	2-4	9
2-4	2.91	2-4	55
3-4	3.00	2-4	13
4-4	3.74	2-6	178
4-5	4.31	3-8	79
4-6	4.34	2-7	271
5-5	4.38	4-6	18
5-6	4.69	4-7	75
6-6	5.23	2-8	151
6-7	5.30	3-6	10
6-8	5.50	4-6	10
Davidson's Flock, 1915-1920			
6-6	5.20	2-7	122
6-7	5.50	4-6	12
			134
Mrs. Bell's Flock, 1915-1923			
4-6	4.46	3-6	15
5-6	4.84	3-6	33
6-6	5.19	3-7	137
6-7	5.63	4-7	22
			207

TABLE III. *Occurrence of multiple births in the thirty-four years of the flock's history.*

Year	Mother two years old, or older					Mother a yearling	
	Sets of triplets	Pairs of twins	Singles	Total births	% multiple births	Pairs of twins	Singles
1890		18	31	49	36.7		5
1891	1	15	44	60	26.6		1
1892		6	56	62	9.6		3
1893		2	63	65	3.1		
1894		1	14	15	6.6		1
1895		1	24	25	4.0		
1896		5	17	22	22.7		
1897		6	14	20	30.0		8
1898		8	19	27	29.6		2
1899		9	24	33	27.2		1
1900		8	29	37	21.6		
1901		2	28	30	6.6		
1902		5	42	47	10.6		
1903		3	47	50	6.0		1
1904		3	56	59	5.1		
1905		3	24	27	11.1		1
1906	1	2	27	30	10.0	1	
1907		3	26	29	10.3		4
1908		6	16	22	27.2		9
1909		6	10	16	37.5	1	11
1910		1	5	6	16.6		3
1911		4	9	13	36.3		5
1912		5	15	20	25.0		3
1913		4	10	14	28.5		4
1914		13	4	17	76.4		6
	Davidson's flock.						
1915		9	9	18	50.0		2
1916	1	9	4	14	71.4	1	2
1917		5	8	13	38.4		
1918		9	5	14	64.2		2
1919		4	9	13	30.7		2
1920		4	6	10	40.0		2
	Mrs. Bell's flock.						
1915	1	3		4	100.0	1	1
1916	1	5	1	7	85.7		2
1917		12	3	15	80.0		4
1918		14	5	19	73.6		
1919	1	10		11	100.0		
1920		7	6	13	53.8		3
1921		12	2	14	85.7		
1922	2	12	1	15	93.3		
1923	3	5	7	15	53.3		1

TABLE IV. *Relation between parents and offspring as regards multiple births.*

General Flock, 1890-1914.					
Parents born as	Young single	Young twins	Young triplets	Per cent multiple births	Total lambs
Both singles	69	42	0[a]	23.3	111
One single, one a twin	189	80	0	17.4	269
Both twins	105	46	0	17.9	151

[A]In Table 3 the fact is indicated that triplets were born in 1891 and again in 1906, but in the former case it was unknown whether either parent was born as single or twin, and in the latter case this was known for the sire only. Hence neither case appears in this table.

Table IV—Continued.

Mrs. Bell's flock, 1915-1923.

Both singles	0	0	0		
One single, one a twin	15	66	3	69.4	84
Both twins	14	68	15	73.5	97
One a twin, one a triplet	3	14	0	70.0	17

Davidson's flock, 1915-1920.

Both singles	3	2	0	25.0	5
One a single, one a twin	22	36	0	45.0	58
Both twins	20	34	0	45.9	54

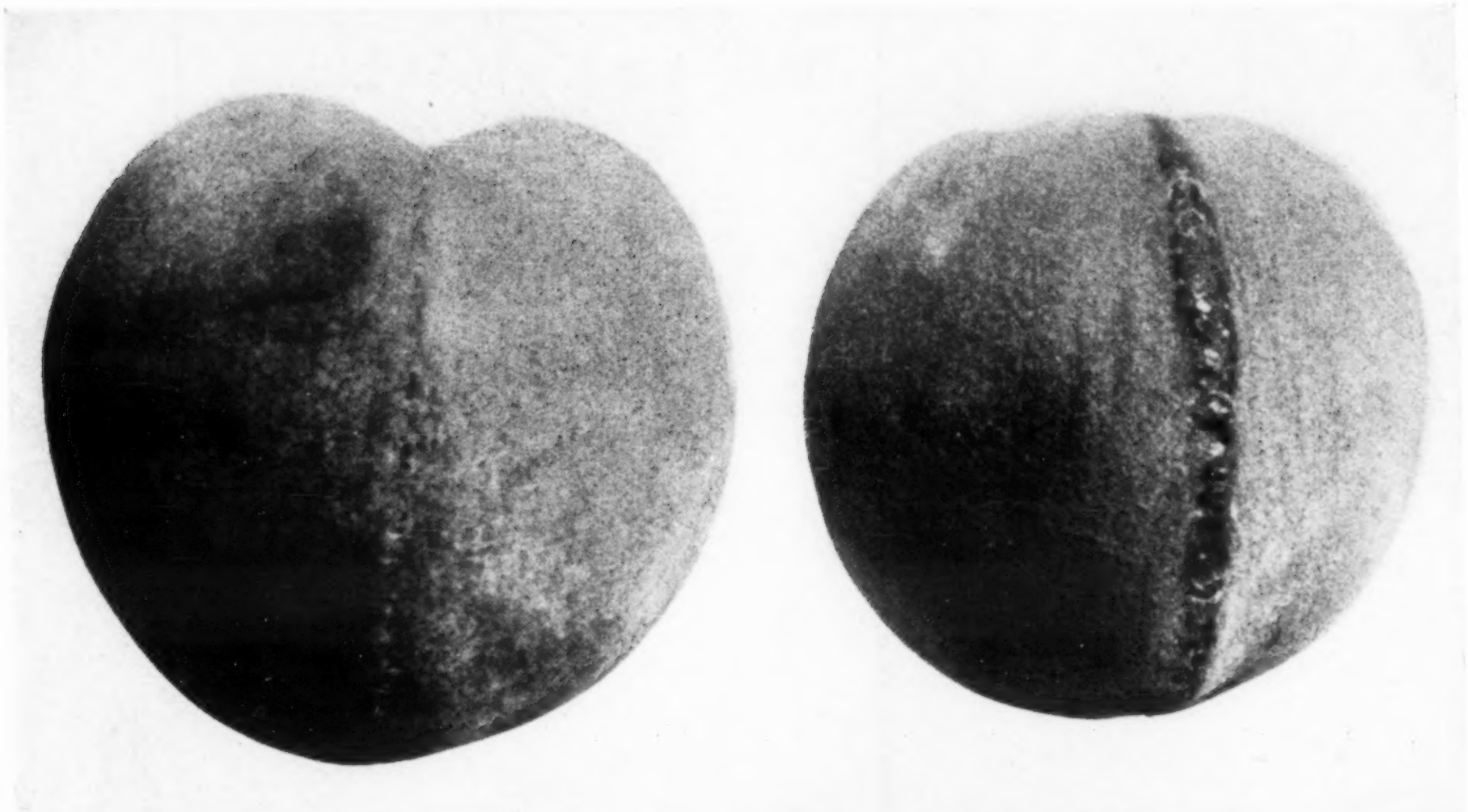
TABLE V. *Relation between mother and offspring as regards multiple births.*

A. General Flock, 1890-1914.				
Mother born	Single births	Twin births	Triplet births	Per cent multiple births
A single	311	55	0	15.0
A twin	121	29	0	19.3
	B. Mrs. Bell's flock, 1915-1923.			
A single	16	33	1	68.0
A twin	7	33	5	84.9
A triplet	1	7	0	
	C. Davidson's flock, 1915-1920.			
A single	17	18	0	51.4
A twin	22	17	0	43.5

INSTABILITY IN PEACH VARIETIES

GEORGE P. WELDON

Chaffey Junior College, Ontario, California



TYPICAL ONTARIO PEACH AND MERRILL MUTANT

FIGURE 14. Fruit of the Merrill sport is shown on the right, that of the parent variety, the Ontario, on the left. The tree on which these peaches grew is shown in Figure 16. Such a sport may be of greater economic value than the parent form, or it may be inferior. Except for the differences in the fruit, such a mutant branch may not be distinguishable from the rest of the tree, so that inferior sports can be kept from propagation only by careful examination of all trees used for budwood.

DEFINITE facts regarding the origin of many of our fruit varieties are difficult to obtain. In the absence of positive knowledge it is a popular thing to ascribe the origin of a new variety to the growth of a chance seedling. Among the many varieties of peaches which are grown commercially in the United States, there are a number whose origin is positively known. There are many which are classed as seedlings which originated by chance or otherwise, but practically none are known to have originated through mutation.

For example, let us turn to Hedrick's descriptions of varieties in his excellent work on the peaches of New York, and let us select from this work twenty-five of the leading varieties of the country, as follows: Alexander, Carman, Champion, Early Crawford, Elberta, Foster, George Fourth, Globe, Greensboro, Hale Early, Heath Cling, J. H. Hale, Late Crawford, Lovell, Mountain Rose, Muir, Old Mixon Cling, Old Mixon Free, Phillips, Salway, Smock, Saint John, Stump, Triumph, Tuskena.

In reading the description of these varieties, we discover that thirteen of them originated as seedlings; nine do not have their origin stated, but merely the place where they originated; and three have nothing to fur-

FRUIT FROM THREE BUDDED MERRILL TREES

FIGURE 15. Showing the uniformity of the mutant form when propagated. The region of the suture, that appears black in the picture, is in reality dark red. The quality of the fruits is about the same as the parent variety, but they ripen about three weeks later.

nish a clue as to where or how they came about. A simple statement of the facts is all that seems necessary to prove either that mutation has played a very small part in originating varieties, or that it has not been given credit for what it has done.

In 1919 the writer began a study of peach varieties with the idea, first, of becoming more familiar with them; secondly, of making a study of bud variations, particularly in their relation to type and production; and thirdly, of locating, if possible, some genuine mutations. This work was undertaken with more or less uncertainty, because of the meagerness of data and the well-grounded notion that mutations in deciduous fruits are rare. Shamel's work with citrus fruits, which began in California in 1909, paved the way for the study of peaches. In Bul. 623 of the U. S. Dept. of Agr., Bureau of Plant Industry, Mr. Shamel states, in connection with his studies of the Washington Navel orange, "Thirteen important strains have been found." It is true that some of these are worthless, but no less interesting (and none are superior to the wonderful Washington Navel variety), yet each comes true to type when propagated by budding or grafting, and entire trees or even orchards of a certain strain are found.

Since the peach problem in my

THE ORIGIN OF THE MERRILL SPORT

FIGURE 16. The branch marked with the handkerchief produces fruit different in appearance from that on the rest of the tree (see Figure 14), and ripening much later.

work occupies a place among a multitude of projects that the average horticultural teacher is expected to work with, there has not been sufficient time to do it justice. Yet enough has been done to justify the statement that instability is found to exist in peach varieties and often enough so that vegetative propagation without intelligent selection of buds will ultimately result in deterioration of varieties.

There are strains of peach varieties (as well as strains of the navel orange), and some of these strains are already being propagated. It is common knowledge among peach growers that there is one strain of the Phillips cling that is practically worthless, and since the writer came to this section in 1919, he has known of whole orchards of this strain being taken out because of the poor character of the fruit. While personal knowledge is not sufficient to enable me to make comparison between the original Phillips and the present peach which bears that name, there is much reliable information to be obtained from various sources, to show that this variety originally had a very small pit, a characteristic much prized

by canners, while at present the pit is much larger. In the case of the Ontario, a local variety which has borne the name Southern Tuscan, my studies have revealed many interesting facts. In this connection a nectarine strain should be mentioned. It is quite common to find peaches of the Ontario variety with a smooth skin, usually only an occasional fruit appearing here and there. That this strain may be propagated by budding is very strongly indicated by two trees typically Ontario so far as foliage is concerned, which were located this season, and upon which every fruit is of the nectarine type. These are growing among ten acres of Ontarios, and only close observation would reveal their character.

I have made another interesting observation for two years in the Chaffey Experimental Orchard. A fifteen-acre block of trees of the Lovell freestone variety has in it two trees which for two seasons, the only seasons in which they have produced fruit, have borne peaches which are typically Lovell in all their characteristics, but which ripen at least ten days in advance of Lovell. The attempt is being made to propagate an early strain of the variety from these trees. Is it not reasonable to suppose that these trees came about because of the use of buds from a Lovell tree, taken from a certain branch which bore this early fruit? If such is not considered to be likely, then in support of the opinion that it is altogether possible, the following account of a bud sport, which I have propagated and which has come true to type, is given. This case is no more striking than another which may furnish material for a subseqeunt article.

Three years ago my attention was called to a tree of the Ontario variety, one branch of which bears fruit that is entirely different from that which is produced by the other branches of the tree. The branch itself is typical of the variety. The leaves have the same characteristic deep serratures, the same shape, the same short, heavy petiole without glands. Until its two kinds of fruit are seen, this tree would never excite any suspicion as to its dual nature. The branch which is the mutant part of the tree occupies about one-third of the entire head. It grows out of the main trunk about eighteen inches from the ground. The position is such as practically to exclude all chance of seedling origin, and its similarity to the Ontario, both in the parent tree and the trees of the second vegetative generation, is sufficient strongly to suggest its origin from Ontario.

For three seasons an opportunity has been presented for observing the fruit. Each season the same very striking characteristic marking of the suture region has been in evidence. The accompanying illustrations will give a better idea than any description as to the appearance of this mutation. The character of the fruit in general as to shape and size and quality is quite typically Ontario, but the time of ripening is about three weeks later. The mark which occurs in the suture region is made up of extraneous tissue which completely fills the suture. It appears first when the fruit is perfectly green and before any other color is evident. For a time it is light red, but as the peach takes on somewhat of the normal deep red of the Ontario variety, this stripe becomes still darker, so that when the fruit is ripe the line may be almost black, still standing out in marked contrast to the color of the rest of the fruit.

Two years ago some buds were taken from the branch which bears this fruit and a few trees were grown by budding into nursery seedlings. This year ten small trees, which constitute the experiment, have borne three fruits. Each fruit was on a different tree. As expected, they came true to type and long before the ripening time the red streak was

beautifully developed. A fourth fruit occurred in some trees which were left heeled in from the previous fall. This fruit was also true to type.

The variety is being grown only as an illustration of a peach mutation. It possesses no special merit. In fact, the deep red color of the stripe extends into the flesh, which, from the canner's standpoint, is an objectionable characteristic. For show purposes it is a striking thing and its principal appeal would be to one who likes novelties.

The variety is being designated as the Merrill, as it originated in an orchard which was planted in the early history of orcharding in the valley by J. R. Merrill. It is not expected that nurserymen will knowingly propagate it because it is inferior to other clings ripening at the same time.

Since there is nothing in the appearance of the branch that bears the mutants to distinguish it from Ontario, anyone cutting budwood in the orchard without a thorough knowledge of each tree might secure a large number of buds from the Merrill sport. It is therefore apparent that nurserymen must know the trees from which they cut budwood, or else things that are far off type may be propagated. Such cases as the one cited may account for many trees that do not come true to name in the orchard.

Enough work has been done during the investigations at Chaffey absolutely to convince the writer that the methods that have been used by nurserymen in cutting budwood from orchards without knowledge of individual trees, or from trees in the nursery that have never borne, should be condemned. In the light of our present knowledge of the subject, he feels that there is no excuse for any nurseryman to neglect the practice of bud selection. The orchards from which budwood is cut should be gone over tree by tree and only those trees which are true to type should be used. An intensive study of the individual branches of a tree is important—perhaps much more so than anyone has yet realized—and the lax methods of the past which have characterized the work of propagating trees must give way in the future to more careful and more intelligent selection.

Non-Hereditary Longevity

Edward W. Horner, 91 years old, the "oldest boy" in Rockville, Md., has a remarkable record.

He did not miss one Sunday school class last year, notwithstanding that he lives more than a mile from the church and must walk the distance in all kinds of weather.

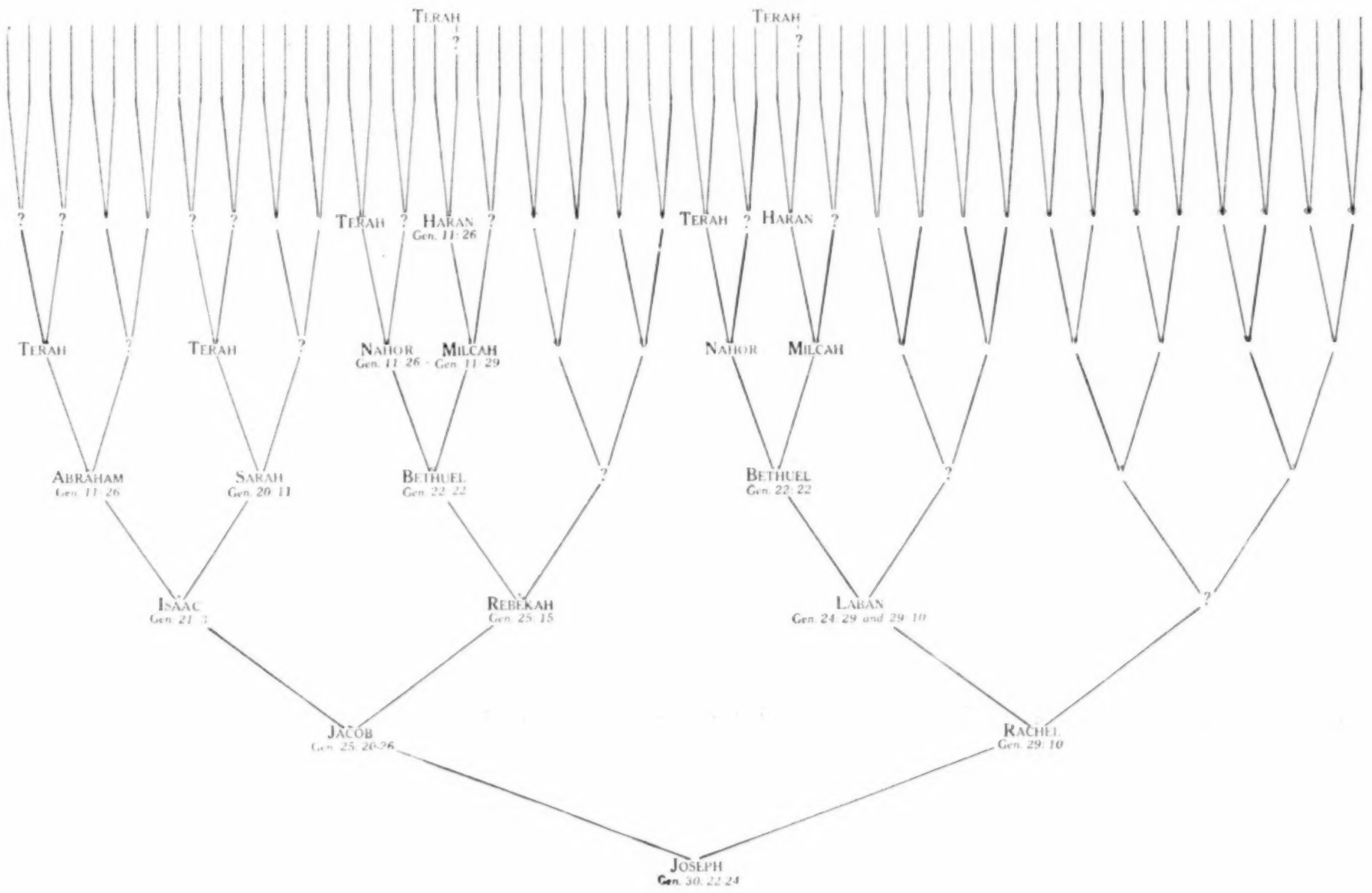
He has been presented with a badge of honor by Frank Higgins, superintendent of the Sunday school.

Mr. Horner attributes his longevity to the fact that he never married.

—*Washington Post.*

THE GENEALOGY OF JOSEPH

WILLIAM A. LIPPINCOTT
The University of California



JOSEPH'S PEDIGREE

FIGURE 17. Though the Old Testament narrative does not give a complete list of Joseph's ancestors for six generations, what information it does give shows the proponderance as ancestors, of Terah and his descendants. Abraham, Nahor and Haran were brothers, and Sarah was Abraham's half-sister. No information regarding the mothers of the three brothers is given, so that the extent to which Joseph was inbred through the wife or wives of Terah cannot be determined.

THE recent very interesting note of Professor Stone in this journal upon "The Genetics of Jacob"* called to mind an observation the writer made some years ago upon the genealogy of Joseph. The salient facts are presented in tabular form herewith.

It is interesting to observe that, according to the Old Testament narrative in the sixth parental generation, Joseph is at least 20.3 per cent inbred.† Instead of tracing to sixty-four different great-great-great-great grandparents as would be the case if his ancestors were unrelated, so far as a six generation ancestral tree indicates, he traces to but fifty-one. It is interesting further to ascertain that according to the narrative this inbreeding is due entirely to the recurrent appearance in the genealogy of one individual —namely, Terah, or his descendants. His name appears twice in the fourth parental generation, twice in the fifth and twice in the sixth, which is the

*Vol. 14, page 228.

†According to Pearl's Method of Calculation.

equivalent of fourteen appearances in the sixth generation. Joseph was distinctly line-bred with reference to Terah.

This being the case, it would be illuminating to learn what manner of man Terah was, or was conceived to be, whether one chooses to look upon Joseph (or Terah) as a historical character or as a legendary hero. In fact, from the standpoint of making known the eugenic ideas and ideals of the early Hebrew people, the latter situation might be of considerably more value. But concerning Terah, the Scriptures are strangely silent.

THE LINCOLN STOCK

. . . "It is for all these reasons that we wish this week to send a special message to our tenant farmers and one-horse farmers all over the South. Perhaps the greatest 'undeveloped resource' of our southern country is found in this class of our population. Nobody knows its possibilities. Abraham Lincoln came from this stock—the man whom the world now acclaims as the greatest figure of the nineteenth century. If they will but have faith in themselves, these men and women, boys and girls of our renter class and one-horse farmer class, then they can surprise even themselves by the greatness of their achievements.

"The truth is that the white renter and one-horse farmer here in the South now has a better chance to get ahead than ever before. For a hundred years the competition of cheap Negro labor has held down the landless white farmer of the South. In order to escape competition with slave labor, hundreds of thousands of Southern white men in the old days went West. Since the Civil War the competition of cheap Negro labor has likewise made it hard for the small white farmer of the South to get ahead. We have had millions of Negroes making cheap cotton on the basis of a cabin for a house, rags for clothing, and cornbread and fat meat for a diet. There has been such an enormous bulk of cheap, ignorant Negro labor making cotton that cotton has been predominantly a cheap labor crop and therefore a cheap crop. The world would not pay the white man 20 cents a pound to grow cotton for it when it could get the Negro to live cheaply enough to make cotton for 10 cents.

"But now all these conditions are changing. The Southern Negro is discovering that there is no real necessity for him to live in a cabin and go half-clad and half-fed. He has gotten some education and he has learned that he can go North and get good wages. Consequently many Negroes are going North, while those who stay here are doing so on condition that they live better. And partly because so many Negroes are going North, cotton production has decreased, prices have increased. In fact, cotton is never again likely to be a cheap-labor crop — and therefore such a cheap crop—as it has been in the past. And all this is in favor of the renter and the small farmer."—

CLARENCE POE, in *The Progressive Farmer*, September 29, 1923.

"DOUBLE EARS" IN BRAHMA CATTLE

Another Case of Apparently Simple Mendelian Inheritance in Farm Animals

JAY L. LUSH

Texas Agricultural Experiment Station

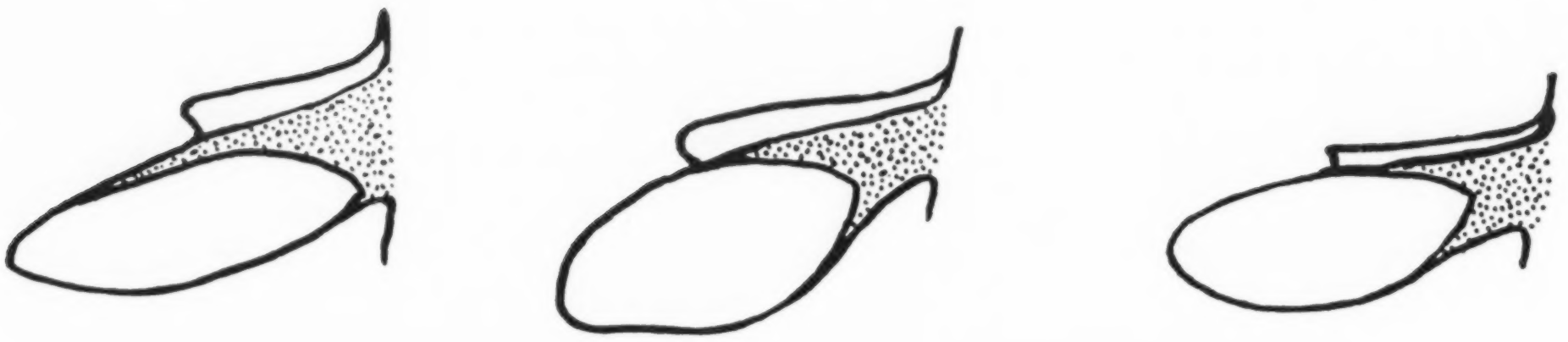
DURING the later part of August, 1923, the writer visited a number of the more prominent ranches which are breeding Brahma cattle in the coastal plain of Texas, from southwest of Houston nearly to the Rio Grande. At several of these ranches cattle with very peculiarly shaped ears were seen, and the information obtained from the different owners was all completely in agreement with the hypothesis that this peculiarity is inherited as a single dominant Mendelian factor. Exact counts of the progeny of the affected individuals could not be obtained because of the methods of breeding on these large ranches, which in general are to let one, two or even three bulls run with a single herd of cows in each pasture during the breeding season, thereby making it uncertain which bull is really the sire of a considerable number of the calves born the following spring. However, the owners and the foremen of these ranches remember the individual cattle and their ancestry even for several generations, to an extent which is almost incredible to the visitor who first sees the cattle and is a bit bewildered by the hundreds of animals which one man seems to recognize individually. In spite of the lack of progeny counts the evidence is believed by the writer to be sufficient to establish with little room for reasonable doubt the simple Mendelian inheritance of the peculiarity and, as there is no prospect of accumulating more data, the description of the peculiarity and the evidence is presented herewith.

The peculiarity is commonly called "double ears" but is really merely a thin, flat piece of cartilage parallel to the main axis of the ear and projecting out of the back surface of the ear very much as the dorsal fin of a fish projects from its back. The accompanying pictures show it but dimly because all of the animals photographed were too wild to permit a good close-up picture to be taken, but with the aid of the diagram the pictures will give the reader a good conception of what the double ear really is. This fold of cartilage (covered of course by skin), varies somewhat in size, or at least in conspicuousness, in different animals but, so far as can be detected by looking at it from a short distance, is always the same in both ears of the same animal. It begins at or near the base of the ear, becomes larger farther out and terminates abruptly, almost pointedly, about half way between the base and the end of the ear. In most cases its plane is almost perpendicular to the surface of the ear but in some cases it bends forward to make an angle, perhaps as small as sixty degrees, with the surface of the ear. Morphologically it is quite distinct from the peculiarity of ear shape reported by the writer* in Jersey cattle and that reported by Yamane† in Ayrshire cattle.

The first occurence of "double ears"

*LUSH, JAY L. An Hereditary Notch in the Ears of Jersey Cattle. *Journal of Heredity*, 13:8-13. 1922.

†YAMANE, J. On the Inheritance of an Aural Abnormality in Ayrshire Cattle. *Jour. Col. Agr. Tohoku Imp. Univ.*, 6:166-170. 1915.



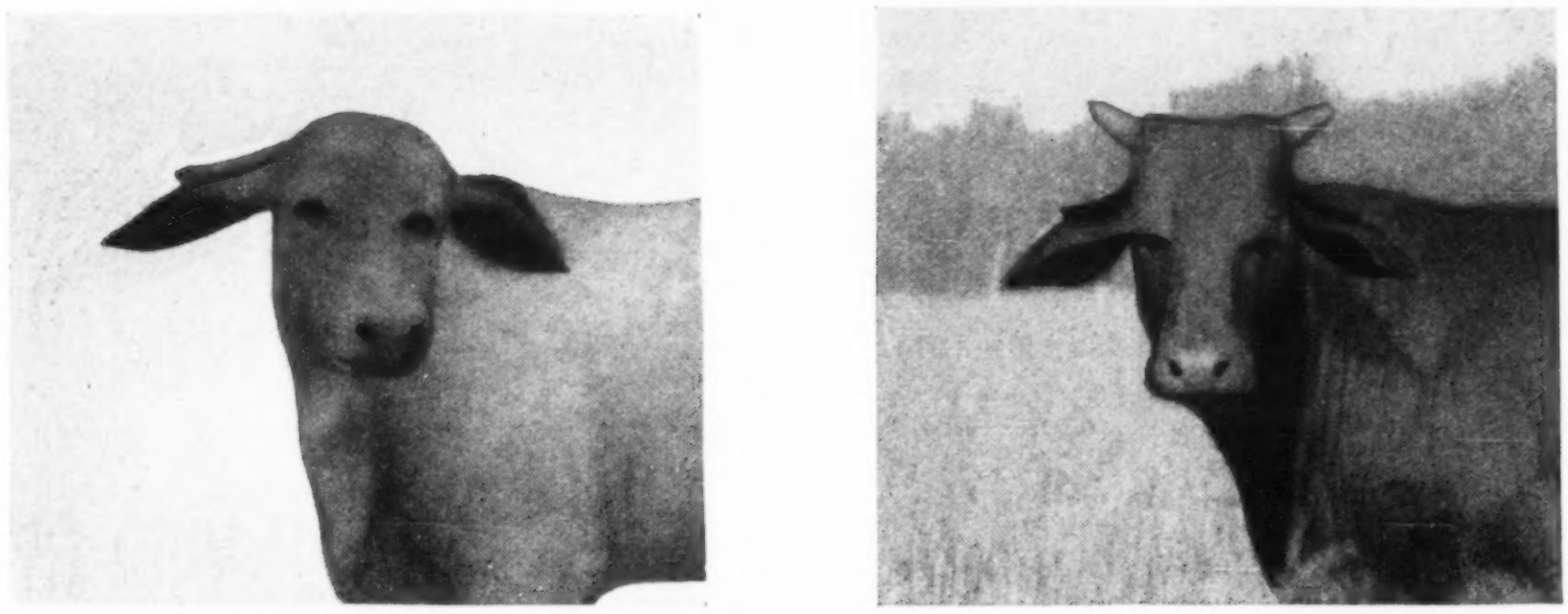
DRAWINGS SHOWING VARIATION OF "DOUBLE EARS"

FIGURE 18. The so-called "double ears" discussed in this article are not in reality double at all. What appears to be a supernumerary ear is a flat piece of cartilage projecting from the back of the ear, much like the dorsal fin of a fish. In some instances this fold projects nearly straight out; in others it bends forward quite abruptly.

about which any of the ranchmen knew was in a bull from the Krishna Valley district of India, imported into Texas in the Pierce-O'Conner importation made by Mr. A. P. Borden in 1906. Only one bull among the thirty-three animals imported possessed this characteristic and the men at Mr. Borden's place state that every double-eared animal is a direct descendant of this bull. Mr. Borden's secretary, who first pointed out the double ear to the writer, stated that he did not know what proportion of this bull's calves had been double-eared but that it was "certainly a large proportion, probably a majority." Mr. Borden himself in answer to the same question, stated that he did not know exactly, but estimated that "between twenty and thirty per cent of this bull's calves were double eared." In the absence of exact counts these statements agree at least permissibly well with the assumption that the double ear is caused by a single dominant Mendelian factor for which the original bull was heterozygous.

In all cases where double-eared cattle were seen on other ranches, their descent could be traced back at least to the Borden importation, and probably to the one double-eared Krishna Valley bull. All of them showed some evidence of Krishna Valley blood in the shape of the head, horns and ears. No case was reported where a double-eared calf was produced by parents neither of which had double ears. In each of the three cases (on the ranch of Mr. Ed C. Lasater, Falfurrias, Texas), in which a double-eared calf was seen and its mother was positively identified, the mother also possessed the double ears.

There are two main conditions which must be satisfied before the hypothesis of the simple Mendelian inheritance of "double ears" as a dominant character can be regarded as positively proved, and there is a third condition which is usually satisfied in such cases. The first condition is that the mating between double-eared and normal individuals should result in either one hundred per cent double-eared progeny or in approximately fifty per cent double-eared and fifty per cent normal. In this particular case, one hundred per cent double-eared progeny is not to be expected because the original double-eared bull was evidently heterozygous. It would have been necessary to have mated some of his double-eared descendants together if any homozygous double-eared individuals were to be produced. Such inbreeding of those descendants has happened very rarely if at all in this case. The necessarily general statements of Mr. Borden and his secretary and of the other ranchmen agree more closely with the idea that fifty per cent of the progeny of the double-eared cattle are double-eared than they could be made to agree with any other Mendelian proportion such as, for example, twenty-five per cent which would be expected if the charac-



HYBRID BRAHMA CATTLE WITH "DOUBLE EARS"

FIGURE 19. These retouched photographs give some idea of how the double ear looks. All cattle having this peculiarity could be traced back with a fair degree of certainty to a single "double-eared" Brahma bull, imported in 1906. The character itself is of no economic importance, but since the hybrid Brahma cattle thrive in regions where the European species does not, stockmen have used the Brahma bulls for breeding purposes without regard to the shape of their ears. The rapid spread of this character is of interest as showing how a variation having no survival value is retained and disseminated by being associated with characters that are advantageous.

ter depended for its expression upon two complementary factors. The second condition is that no double-eared calves could be produced from a mating in which neither parent was double-eared. No such case was reported to the writer in spite of diligent inquiry and, as stated above, in the three cases where the mothers of double-eared calves were positively identified by the writer the mothers themselves were double-eared. The third condition, which is usually fulfilled in cases of simple Mendelian inheritance, is the absence of intermediates. That condition was fulfilled in this case because, although the projection on the ear varied somewhat in size and conspicuousness in different individuals, the least extreme case of double-ear was nevertheless very definite and distinctive. Moreover double-eared bulls have sired double-eared bull calves from normal cows and therefore the character is not sex-linked.

Therefore it seems to the writer that the evidence is sufficient to add this to the growing list of characters found to be inherited in a Mendelian manner in our domestic animals. Each addition to this list seems to the writer to make it more probable that all or nearly all of *inheritance* is Mendelian although the *expression* of the inherited factors in *characteristics* of the living animals is complicated by interactions between the factors and by environmental influences.

Another point of especial interest as bearing on problems of natural selection and adaption is that this character which is, so far as anyone can tell, of no economic importance whatever, nevertheless occurs much more abundantly now than it did seventeen years ago, when there was only one double-eared bull in the entire region. Of course the reason for this is plain in this case; the cattlemen of Southern Texas desired more Brahma blood in their herds and they took the double-eared Brahmas as well as the normal ones, not because they wanted the double-ear but because it happened to be associated accidentally with supposedly desirable Brahma characteristics. However, students of paleontology, comparative anatomy, and geographical distribution are frequently

puzzled by the widespread distribution of some apparently useless character. May it not be that if the complete histories of these cases were known, it would be found for many of them that the useless character was accidentally associated with others which did have a high value in natural selection? This idea is not novel but the case of the double ear in the Brahma cattle of Texas furnishes an illustration of how that may have happened.

The Anthropology of Germany

RASSENKUNDE DES DEUTSCHEN VOLKES, by DR. F. R. GUENTHER, with 472 illus. Price, $2.25. Munich, J. F. Lehmann's Verlag. 1923.

Dr. Guenther's object is frankly to create among the German people a race-consciousness favorable to the perpetuation of the Nordics. Believing that such a consciousness must be based on knowledge, he presents a study of the principal races of Europe, going back into their history as far as possible, and then analyzing their distribution in Germany. His book thus invites comparison with "The Passing of the Great Race;" in wealth of detail and pictorial illustration it is more ambitious than Madison Grant's book.

The author's classification is a little different from that usually followed in America. In addition to the Nordic and the Mediterranean races—the latter called by him the western race—he divides the Alpine race in two: the eastern (ostisch) and the dinaric. The latter is characterized by tall stature, as a most noticeable mark of differentiation.

Introductory chapters give a brief history of physical authropology and a review of the methods in use to study races, together with a consideration of the meaning of the word "race" itself. An appendix of 75 pages is devoted to the Jews.

The book is of course open to criticism in many details, while many will disagree with its entire point of view of exalting the Nordics. Nevertheless, the encyclopedic work with its hundreds of illustrations can not be read by any one without giving a clearer and more vivid understanding of racial differences. Every civilized country ought to possess a book of this sort referring to its own particular racial problems.